

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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TITLE : GALVANICALLY-ACTIVE *IN SITU*
FORMED PARTICLES FOR
CONTROLLED RATE DISSOLVING
TOOLS

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FIRST AMENDMENT FOR EX PARTE REEXAMINATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Following the non-final Office Action mailed November 19, 2021, please amend the above-identified application as follows.

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks begin on page 17 of this paper.

AMENDMENTS TO THE CLAIMS:

The listing of the claims will replace all prior versions, and the listing of the claims in the application:

LISTING OF THE CLAIMS

1. (Original) A magnesium composite that includes *in situ* precipitation of galvanically-active intermetallic phases to enable controlled dissolution of said magnesium composite, said magnesium composite comprising a mixture of magnesium or a magnesium alloy and an additive material, said additive material having a greater melting point temperature than a solidus temperature of said magnesium, said additive material constituting about 0.05 wt. %-45 wt. % of said mixture, said additive material forming precipitant in said magnesium composite, said additive material includes one or more metals selected from the group consisting of copper, nickel, iron, and cobalt, said magnesium composite has a dissolution rate of at least 5 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

2. (Original) The magnesium composite as defined in claim 1, wherein said magnesium alloy includes over 50 wt. % magnesium and one or more metals selected from the group consisting of aluminum, boron, bismuth, zinc, zirconium, and manganese.

3. (Original) The magnesium composite as defined in claim 1, wherein said magnesium alloy includes over 50 wt. % magnesium and one or more metals selected from the group consisting of aluminum in an amount of about 0.5-10 wt. %, zinc in amount of about 0.1-3 wt. %, zirconium in an amount of about 0.01-1 wt. %, manganese in an amount of about 0.15-2 wt. %, boron in amount of about 0.0002-0.04 wt. %, and bismuth in amount of about 0.4-0.7 wt. %.

4. (Original) The magnesium composite as defined in claim 1, wherein said additive material includes nickel, said nickel constitutes about 0.05-35 wt. % of said magnesium composite, said nickel forms galvanically-active in situ precipitate in said magnesium composite.

5. (Original) The magnesium composite as defined in claim 1, wherein said additive material includes copper, said copper constitutes about 0.05-35 wt. % of said magnesium composite, said copper forms galvanically-active in situ precipitate in said magnesium composite.

6. (Original) The magnesium composite as defined in claim 1, wherein said additive material includes cobalt, said cobalt constitutes about 0.05-35 wt. % of said magnesium composite, said cobalt forms galvanically-active in situ precipitate in said magnesium composite.

7. (Original) The magnesium composite as defined in claim 1, where said magnesium composite is subjected to a deformation processing to reduce grain size of said magnesium composite, increase tensile yield strength of said magnesium composite, increase elongation of said magnesium composite, or combinations thereof.

8. (Original) The magnesium composite as defined in claim 1, wherein said magnesium composite is subjected to a surface treatment to improve a surface hardness of said magnesium composite, said surface treatment including peening, heat treatment, aluminizing, or combinations thereof.

9. (Original) The magnesium composite as defined in claim 1, wherein a dissolution rate of said magnesium composite is about 5-325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90°C.

10. (Original) The magnesium composite as defined in claim 1, wherein a dissolution rate of said magnesium composite is controlled by an amount and size of said in situ formed

galvanically-active particles whereby smaller average sized particles of said *in situ* formed galvanically-active particles, a greater weight percent of said *in situ* formed galvanically-active particles in said magnesium composite, or combinations thereof increases said dissolution rate of said magnesium composite.

11. (Original) The magnesium composite as defined in claim 1, wherein said additive material is a metal or metal alloy.

12. (Original - Amended) A magnesium composite that includes *in situ* precipitation of galvanically-active intermetallic phases to enable controlled dissolution of said magnesium composite comprising a mixture of a magnesium or a magnesium alloy and an additive material, said additive material having a greater melting point temperature than a solidus temperature of said magnesium, said composite including greater than 50 wt. % magnesium, said additive material constituting about 0.05-45 wt. % of said magnesium composite, said additive material having a melting point temperature that is 100° [C.] C greater than a melting temperature of said magnesium or magnesium alloy, said additive material including one or more metals selected from the group consisting of copper, nickel, cobalt, titanium, and iron, at least a portion of said additive material remaining unalloyed additive material, said magnesium composite including *in situ* precipitation of galvanically-active intermetallic phases that includes said unalloyed additive material, said magnesium composite has a dissolution rate of at least 5 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

13. (Original) The magnesium composite as defined in claim 12, wherein said additive material is added to said magnesium or magnesium alloy while said magnesium or magnesium alloy is at a temperature that is above said solidus temperature of said magnesium and a temperature that is less than a melting point of said additive material to form said mixture.

14. (Original) The magnesium composite as defined in claim 13, wherein said magnesium alloy includes over 50 wt. % magnesium and one or more metals selected from the group consisting of aluminum in an amount of about 0.5-10 wt. %, zinc in amount of about 0.1-3 wt. %, zirconium in an amount of about 0.01-1 wt. %, manganese in an amount of about 0.15-2 wt. %, boron in amount of about 0.0002-0.04 wt. %, and bismuth in an amount of about 0.4-0.7 wt. %.

15. (Original) The magnesium composite as defined in claim 14, wherein said additive material includes nickel, said nickel constitutes about 0.05-35 wt. % of said magnesium composite, said nickel forms galvanically-active in situ precipitate in said magnesium composite.

16. (Original) The magnesium composite as defined in claim 15, wherein said additive material includes nickel, said nickel constitutes about 3-7 wt. % of said magnesium composite.

17. (Original) The magnesium composite as defined in claim 15, wherein said additive material includes nickel, said nickel constitutes about 7-10 wt. % of said magnesium composite.

18. (Original - Amended) The magnesium composite as defined in claim 15, wherein a dissolution rate of said magnesium composite is at least 45 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° [C.] C and up to 325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

19. (Original) The magnesium composite as defined in claim 12, wherein said magnesium alloy includes over 50 wt. % magnesium and one or more metals selected from the group consisting of aluminum in an amount of about 0.5-10 wt. %, zinc in amount of about 0.1-6 wt. %, zirconium in an amount of about 0.01-3 wt. %, manganese in an amount of about 0.15-2 wt. %, boron in amount of about 0.0002-0.04 wt. %, and bismuth in an amount of about 0.4-0.7 wt. %.

20. (Original) The magnesium composite as defined in claim 12, said additive material includes nickel, said nickel constitutes about 0.05-35 wt. % of said magnesium composite, said nickel forms galvanically-active in situ precipitate in said magnesium composite.

21. (Original) The magnesium composite as defined in claim 20, wherein said additive material includes nickel, said nickel constitutes about 3-7 wt. % of said magnesium composite.

22. (Original) The magnesium composite as defined in claim 20, wherein said additive material includes nickel, said nickel constitutes about 7-10 wt. % of said magnesium composite.

23. (Original - Amended) The magnesium composite as defined in claim 12, wherein a dissolution rate of said magnesium composite is at least 45 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° [C.] C and up to 325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

24. (Original) The magnesium composite as defined in claim 12, wherein said additive material is a metal or metal alloy.

25. (Original) A dissolvable magnesium alloy composite for use in a ball or other tool component in a well drilling or completion operation, said dissolvable magnesium alloy composite comprising at least 85 wt. % magnesium; one or more metals selected from the group consisting of 0.5-10 wt. % aluminum, 0.05-6 wt. % zinc, 0.01-3 wt. % zirconium, and 0.15-2 wt. % manganese; and about 0.05-45 wt. % of a secondary metal to form a galvanically-active intermetallic particle that promotes corrosion of said dissolvable magnesium alloy composite, said secondary metal including one or more metals selected from the group consisting of copper, nickel, cobalt, titanium and iron, said magnesium alloy composite has a dissolution rate of at least 5 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

26. (Original) The dissolvable magnesium alloy composite as defined in claim 25, wherein a dissolution rate of said magnesium alloy composite is 100-325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

27. (Original) The dissolvable magnesium composite as defined in claim 25, wherein said secondary metal includes nickel, said nickel forms galvanically-active in situ precipitate in said magnesium composite.

28. (Original) The dissolvable magnesium alloy composite as defined in claim 25, wherein said additive material is a metal or metal alloy.

29. (Original) A dissolvable magnesium alloy composite for use in a ball or other tool component in a well drilling or completion operation, said dissolvable magnesium alloy composite comprising 60-95 wt. % magnesium; 0.01-1 wt. % zirconium; and about 0.05-45 wt. % of a secondary metal to form a galvanically-active intermetallic particle that promotes corrosion of said dissolvable magnesium alloy composite, said secondary metal including one or more metals selected from the group consisting of copper, nickel, cobalt, titanium and iron, said magnesium alloy composite has a dissolution rate of at least 5 mg/cm²/hr. in 3 wt. % KCl water mixture at 90°C.

30. (Original) The dissolvable magnesium alloy composite as defined in claim 29, wherein a dissolution rate of said magnesium alloy composite is 5-325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

31. (Original) The dissolvable magnesium composite as defined in claim 29, wherein said secondary metal includes nickel, said nickel forms galvanically-active in situ precipitate in said magnesium composite.

32. (Original) The dissolvable magnesium alloy composite as defined in claim 29, wherein said additive material is a metal or metal alloy.

33. (Original) A dissolvable magnesium alloy composite for use in a ball or other tool component in a well drilling or completion operation, said dissolvable magnesium alloy composite comprising 60-95 wt. % magnesium; 0.5-10 wt. % aluminum; 0.05-6 wt. % zinc; 0.15-2 wt. % manganese; and about 0.05-45 wt. % of a secondary metal to form a galvanically-active intermetallic particle that promotes corrosion of said dissolvable magnesium alloy composite, said secondary metal including one or more metals selected from the group consisting of copper, nickel, cobalt, titanium and iron, said magnesium alloy composite has a dissolution rate of at least 5 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

34. (Original - Amended) The dissolvable magnesium alloy composite as defined in claim 33, wherein a dissolution rate of said magnesium alloy composite is 5-325 [mg/cm²/hr.] mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

35. (Original) The dissolvable magnesium composite as defined in claim 33, wherein said secondary metal includes nickel, said nickel forms galvanically-active in situ precipitate in said magnesium composite.

36. (Original) The dissolvable magnesium alloy composite as defined in claim 33, wherein said additive material is a metal or metal alloy.

37. (Original) A dissolvable magnesium alloy composite for use in a ball or other tool component in a well drilling or completion operation, said dissolvable magnesium alloy composite comprising 60-95 wt. % magnesium; 0.05-6 wt. % zinc; 0.01-1 wt. % zirconium; and about 0.05-45 wt. % of a secondary metal to form a galvanically-active intermetallic particle that promotes corrosion of said dissolvable magnesium alloy composite, said secondary metal including one or

more metals selected from the group consisting of copper, nickel, cobalt, titanium and iron, said magnesium alloy composite has a dissolution rate of at least 5 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

38. (Original) The dissolvable magnesium alloy composite as defined in claim 37, wherein a dissolution rate of said magnesium alloy composite is 5-325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

39. (Original) The dissolvable magnesium composite as defined in claim 37, wherein said secondary metal includes nickel, said nickel forms galvanically-active in situ precipitate in said magnesium composite.

40. (Original) The dissolvable magnesium alloy composite as defined in claim 37, wherein said additive material is a metal or metal alloy.

41. (Original) A dissolvable magnesium alloy composite for use in a ball or other tool component in a well drilling or completion operation, said dissolvable magnesium alloy composite comprising over 50 wt. % magnesium; one or more metals selected from the group consisting of 0.5-10 wt. % aluminum, 0.1-2 wt. % zinc, 0.01-1 wt. % zirconium, and 0.15-2 wt. % manganese; and about 0.05-45 wt. % of a secondary metal to form a galvanically-active intermetallic particle that promotes corrosion of said dissolvable magnesium alloy composite, said secondary metal including one or more metals selected from the group consisting of copper, nickel and cobalt, said magnesium alloy composite has a dissolution rate of at least 5 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

42. (Original) The dissolvable magnesium alloy composite as defined in claim 41, wherein a dissolution rate of said magnesium alloy composite is 5-325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

43. (Original) The dissolvable magnesium composite as defined in claim 41, wherein said secondary metal includes nickel, said nickel forms galvanically-active in situ precipitate in said magnesium composite.

44. (Original) The dissolvable magnesium alloy composite as defined in claim 41, wherein said additive material is a metal or metal alloy.

45. (Original) A dissolvable magnesium alloy composite for use in a ball or other tool component in a well drilling or completion operation, said dissolvable magnesium alloy composite comprising over 50 wt. % magnesium; one or more metals selected from the group consisting of 0.1-3 wt. % zinc, 0.01-1 wt. % zirconium, 0.05-1 wt. % manganese, 0.0002-0.04 wt. % boron, and 0.4-0.7 wt. % bismuth; and about 0.05-45 wt. % of a secondary metal to form a galvanically-active intermetallic particle that promotes corrosion of said dissolvable magnesium alloy composite, said secondary metal including one or more metals selected from the group consisting of copper, nickel, and cobalt, said magnesium alloy composite has a dissolution rate of at least 5 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

46. (Original) The dissolvable magnesium alloy composite as defined in claim 45, wherein a dissolution rate of said magnesium alloy composite is 5-325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

47. (Original) The dissolvable magnesium composite as defined in claim 45, wherein said secondary metal includes nickel, said nickel forms galvanically-active in situ precipitate in said magnesium composite.

48. (Original) The dissolvable magnesium alloy composite as defined in claim 45, wherein said additive material is a metal or metal alloy.

49. (Original) A magnesium composite that includes *in situ* precipitation of galvanically-active intermetallic phases to enable controlled dissolution of said magnesium composite, said magnesium composite comprising a mixture of magnesium or a magnesium alloy and an additive material, said additive material constituting about 0.05-45 wt. % of said mixture, said additive material includes one or more metals selected from the group consisting of copper, nickel, titanium, iron, and cobalt, said magnesium composite including *in situ* precipitation of galvanically-active intermetallic phases that include said additive material, said additive material located in sufficient quantities in said galvanically-active intermetallic phases so as to obtain a composition and morphology of said galvanically-active intermetallic phases such that a galvanic corrosion rate along said galvanically-active intermetallic phases causes said magnesium composite to have a dissolution rate of at least at least 5 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

50. (Original) The magnesium composite as defined in claim 49, wherein said additive material includes one or more metals selected from the group consisting of copper, nickel, and cobalt.

51. (Original) The magnesium composite as defined in claim 49, wherein said additive material includes particles having an average particle diameter size of about 0.1-500 microns.

52. (Original) The magnesium composite as defined in claim 49, wherein said magnesium alloy includes over 50 wt. % magnesium, and one or more metals selected from the group consisting of aluminum, boron, bismuth, zinc, zirconium, and manganese.

53. (Original) The magnesium composite as defined in claim 49, wherein said magnesium alloy includes over 50 wt. % magnesium, and one or more metals selected from the group consisting of aluminum in an amount of about 0.5-10 wt. %, zinc in an amount of about 0.1-6 wt. %, zirconium in an amount of about 0.01-3 wt. %, manganese in an amount of about 0.15-2 wt. %, boron in an amount of about 0.0002-0.04 wt. %, and bismuth in amount of about 0.4-0.7 wt. %.

54. (Original) The magnesium composite as defined in claim 49, wherein said magnesium alloy includes over 50 wt. % magnesium, and one or more metals selected from the group consisting of aluminum in an amount of about 0.5-10 wt. %, zinc in an amount of about 0.1-3 wt. %, zirconium in an amount of about 0.01-1 wt. %, manganese in an amount of about 0.15-2 wt. %, boron in an amount of about 0.0002-0.04 wt. %, and bismuth in an amount of about 0.4-0.7 wt. %.

55. (Original) The magnesium composite as defined in claim 49, wherein said magnesium alloy includes at least 85 wt. % magnesium, and one or more metals selected from the group consisting of 0.5-10 wt. % aluminum, 0.05-6 wt. % zinc, 0.01-3 wt. % zirconium, and 0.15-2 wt. % manganese.

56. (Original) The magnesium composite as defined in claim 49, wherein said magnesium alloy includes 60-95 wt. % magnesium and 0.01-1 wt. % zirconium.

57. (Original) The magnesium composite as defined in claim 56, wherein said magnesium alloy further includes 0.05-6 wt. % zinc.

58. (Original) The magnesium composite as defined in claim 49, wherein said magnesium alloy includes 60-95 wt. % magnesium, 0.5-10 wt. % aluminum, 0.05-6 wt. % zinc, and 0.15-2 wt. % manganese.

59. (Original) The magnesium composite as defined in claim 49, wherein said magnesium alloy includes over 50 wt. % magnesium and one or more metals selected from the group consisting of 0.5-10 wt. % aluminum, 0.1-2 wt. % zinc, 0.01-1 wt. % zirconium, and 0.15-2 wt. % manganese.

60. (Original) The magnesium composite as defined in claim 49, wherein said magnesium alloy includes over 50 wt. % magnesium, and one or more metals selected from the group consisting of 0.1-3 wt. % zinc, 0.01-1 wt. % zirconium, 0.05-1 wt. % manganese, 0.0002-0.04 wt. % boron, and 0.4-0.7 wt. % bismuth.

61. (Original) The magnesium composite as defined in claim 49, wherein said additive material includes nickel, said nickel constitutes about 0.05-35 wt. % of said magnesium composite, said nickel forms galvanically-active in situ precipitate in said magnesium composite.

62. (Original) The magnesium composite as defined in claim 61, wherein said nickel constitutes about 3-7 wt. % of said magnesium composite.

63. (Original) The magnesium composite as defined in claim 61, wherein said nickel constitutes about 7-10 wt. % of said magnesium composite.

64. (Original) The magnesium composite as defined in claim 49, wherein said additive material includes copper, said copper constitutes about 0.05-35 wt. % of said magnesium

composite, said copper forms the galvanically-active in situ precipitate in said magnesium composite.

65. (Original) The magnesium composite as defined in claim 49, wherein said additive material includes cobalt, said cobalt constitutes about 0.05-35 wt. % of said magnesium composite, said cobalt forms the galvanically-active in situ precipitate in said magnesium composite.

66. (Original) The magnesium composite as defined in claim 49, wherein a dissolution rate of said magnesium composite is about 5-325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

67. (Original - Amended) The magnesium composite as defined in claim 49, wherein a dissolution rate of said magnesium composite is at least 45 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° [C.] C and up to 325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

68. (Original) The magnesium composite as defined in claim 49, wherein a dissolution rate of said magnesium composite is up to 1 mg/cm²/hr. in 3 wt. % KCl water mixture at 21° C.

69. (Original – Amended) The magnesium composite as defined in claim 49, wherein said additive material has a melting point temperature that is 100° [C.] C greater than a melting temperature of said magnesium or magnesium alloy.

70. (Original) The magnesium composite as defined in claim 49, wherein said magnesium composite is at least partially included in a down hole well component, said down hole well component including one or more components selected from the group consisting of a sleeve, frac ball, hydraulic actuating tooling, tube, valve, valve component, or plug.

71. (Original) The magnesium composite as defined in claim 49, wherein at least a portion of said additive material remains unalloyed additive material in said magnesium composite.

72. (Original) The magnesium composite as defined in claim 49, wherein said additive material is a metal or metal alloy.

73. (Original) A dissolvable magnesium composite for use in a ball or other tool component in a well drilling or completion operation, said dissolvable magnesium composite includes *in situ* precipitation of galvanically-active intermetallic phases to enable controlled dissolution of said magnesium composite, said magnesium composite comprising a mixture of magnesium or a magnesium alloy and an additive material, said additive material constituting about 0.05 wt. % of said mixture, said additive material is a metal or metal alloy, said additive material includes one or more metals selected from the group consisting of copper, nickel, titanium, iron, silicon, and cobalt, said magnesium composite including *in situ* precipitation of galvanically-active intermetallic phases that include said additive material, said additive material located in sufficient quantities in said galvanically-active intermetallic phases so as to obtain a composition and morphology of said galvanically-active intermetallic phases such that a galvanic corrosion rate along said galvanically-active intermetallic phases causes said magnesium composite to have a dissolution rate of at least at least 5 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

74. (Original) A dissolvable magnesium composite for use in a ball or other tool component in a well drilling or completion operation, said dissolvable magnesium composite includes *in situ* precipitation of galvanically-active intermetallic phases to enable controlled dissolution of said magnesium composite, said magnesium composite comprising a mixture of

magnesium or a magnesium alloy and an additive material, said additive material constituting at least 0.1 wt. % of said mixture, said magnesium in said magnesium composite constituting at least 85 wt. %, said additive material is a metal material selected from the group consisting of copper, nickel and cobalt, said magnesium composite including *in situ* precipitation of galvanically-active intermetallic phases that include said additive material, said magnesium composite has a dissolution rate of 84-325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

75. (Original) The magnesium composite as defined in claim 74, wherein said magnesium alloy is an AZ91D magnesium alloy that includes aluminum and zinc.

76. (Original) The magnesium composite as defined in claim 74, wherein said additive material includes nickel, a content of said nickel in said magnesium composite is at least 0.3 wt.%.

77. (Original) The magnesium composite as defined in claim 74, wherein said additive material includes nickel, a content of said nickel in said magnesium composite is at least 7 wt. %.

78. (Original) The magnesium composite as defined in claim 74, wherein said additive material includes nickel, a content of said nickel in said magnesium composite is at least 10 wt. %.

REMARKS

Applicant has now had an opportunity to carefully consider the Examiner's comments set forth in the non-final Office Action (hereinafter "NFOA") of November 19, 2021. U.S. Patent No. 10,329,653 being reexamined under Application Serial No. 90/014,795 (hereinafter, "the '795 Reexam") includes claims 1-78. The NFOA indicates that claims 6, 10, 17, 22, 51, 63, 65, 68, 77 and 78 are not subject to the reexamination. Claims 12, 18, 23, 34, 67 and 69 have been amended.

I. Support for Claim Amendments

Claims 12, 18, 23, 34, 67 and 69 of the '795 Reexam have been amended to correct typographical errors in the claims. Applicant submits that such amendments do not constitute new matter. Applicant requests entry of these claim amendments.

II. 35 U.S.C. 102

Claim 1-5, 9, 11, 29-32, 37-50, 52-54, 56, 57, 59-62, 64, 66, 67, 69, 70, 72 and 73 of the '795 Reexam are rejected under U.S.C. 102(a)(1) as being anticipated by Chinese Pat. Pub. No. CN 103343271 to Xiao et al. (hereinafter "Xiao").

A. Xiao

Xiao teaches that an objective of the magnesium alloy is to create a magnesium alloy that is "able to meet the requirements for the decomposition of a tripping ball used in the multi-stage sliding sleeve staged-fracturing technique." (Xiao - ¶ 5). Xiao states that known AZ91D magnesium alloy formed of 8.3-9.7 wt.% aluminum, 0.35-1 wt.% zinc, 0.015-0.5 wt.% manganese and the balance magnesium has a compressive strength (Tensile Strength) of less than 250 MPa and an extremely low decomposition rate of $\leq 5 \times 10^{-4}$ g/cm²/hr. (≤ 0.5 mg/cm²/hr.) in in 3% KCl solution at 93°C; thus, such AZ91D magnesium alloy is unable to meet the requirements of a tripping ball material in the multi-stage sliding sleeve staged fracturing technology. (Xiao - ¶ 3;

Tables 1-2). Xiao teaches that a decomposition rate of greater than 0.02 g/cm²/hr. in 3% KCl solution at 93°C is required to meet the dissolution requirements of a dissolvable tripping ball. (Xiao - ¶4).

Paragraphs 6-11 and Claim 1 of Xiao teach that a magnesium alloy solely formed of 13-25 wt.% aluminum, 2-15 wt.% zinc, and the balance magnesium meets the compressive strength (Tensile Strength) and decomposition rate requirements of a tripping ball, namely a magnesium alloy having equal to or greater than 250 MPA compressive strength and a decomposition rate of greater than 0.02 g/cm²/hr. in 3% KCl solution at 93° C.

Xiao teaches that the purpose of adding large quantities of aluminum to the magnesium alloy “is to produce a large amount of cathode phase, the β (Mg₁₇Al₁₂) phase and eutectic phase on the grain boundary of the magnesium alloy, and the magnesium matrix α phase functions as an anode phase, so that the matrix and the grain boundary of the magnesium alloy form a large amount of micro-batteries, which greatly accelerate the corrosion decomposition of magnesium alloy.” (Xiao - ¶ 26). Xiao also teaches that the aluminum content of the magnesium alloy must not exceed 25 wt.% because excessive addition of aluminum would reduce the volume fraction of the anode phase, the α phase, thereby reducing the number of micro-batteries formed in the magnesium alloy. (Xiao - ¶ 26).

Xiao teaches that the zinc added to the magnesium alloy is to increase the compressive strength (Tensile Strength) of the magnesium alloy, but the amount of zinc added to the magnesium alloy must be controlled to be no more than 15 wt.% since excessive zinc addition would reduce the volume fraction of the cathode phase, the β (Mg₁₇Al₁₂) phase, in the magnesium alloy. (Xiao - ¶ 26). Xiao teaches that the zinc additions to the magnesium alloy increase the compressive

strength (Tensile Strength) of the magnesium alloy by 130-180 MPa as compared to an AZ91D magnesium alloy. (Xiao - ¶ 26).

Xiao teaches that the aluminum content in the magnesium alloy is the principal component for causing the corrosion decomposition of magnesium alloy, and that such aluminum content must be at least 13 wt.%, but no more than 25 wt.%, of the magnesium alloy. (Xiao - ¶¶ 6-20, 26; Claim 1). Xiao teaches that magnesium alloy that includes less than 13 wt.% aluminum (e.g., AZ91D magnesium alloy formed of 8.3-9.7 wt.% aluminum) does not have a decomposition rate of greater than 0.02 g/cm²/hr. (20 mg/cm²/hr.). (Xiao - ¶¶ 3-5, 26; Tables 1-2). Xiao also teaches that a zinc content in the magnesium alloy of at least 2 wt.% and no more than 15 wt.% is required to form a magnesium alloy that has a greater compressive strength (Tensile Strength) than existing AZ91D magnesium alloys. (Xiao - ¶ 26). Xiao teaches that a magnesium alloy that includes less than 2 wt.% zinc (e.g., AZ91D magnesium alloy formed of 0.35-1 wt.% Zn) will have a compressive strength of less than 250 MPa, which is an unacceptable compressive strength (Tensile Strength) for a tripping ball. (Xiao - ¶ 3).

Thus, Xiao teaches that the necessary metal additives in the magnesium alloy to form a metal alloy that has the required compressive strength (e.g., at least 250 MPa) and decomposition rate (greater than 0.02 g/cm²/hr. in 3% KCl solution at 93° C) for a tripping ball for use in multi-stage sliding sleeve staged fracturing technology is a magnesium alloy that includes 13-25 wt.% aluminum and 2-15 wt.% zinc. (Xiao - ¶¶ 6-20, 26; Claim 1).

Xiao teaches that small amounts of optional metals can be included in the magnesium alloy; however, these optional metals are merely used to enhance corrosion performance (e.g., iron, copper, nickel, silver), or function as a grain refiner (e.g., zirconium, titanium) to improve compressive strength (Tensile Strength) of the magnesium alloy. (Xiao - ¶¶ 12-20, 26; Claims 2-

3). These metal additives are not required to form a magnesium alloy that has greater than 250 MPa compression strength and a decomposition rate of greater than 0.02 g/cm²/hr. in 3% KCl solution at 93° C. Thus, Xiao teaches that the inclusion of such metal additives is unnecessary to form a magnesium alloy that has the required compressive strength (Tensile Strength) and decomposition rate for a tripping ball for use in multi-stage sliding sleeve staged fracturing technology.

Xiao teaches that when one or more optional metal additives are added to the magnesium alloy, the magnesium content of the magnesium alloy is reduced to accommodate the inclusion of such optional metal additives. (Xiao - ¶¶ 12-20, 26, 33-60; Table 1; Claims 1-3).

Xiao teaches that when the optional metal additives are included in the magnesium alloy, the magnesium alloy includes the additional metal additives of iron, copper, nickel, zirconium, and titanium. (Xiao - ¶¶ 12-20, 26; Table 1; Claim 2). Silver and copper are the only metal additives that are taught as being optionally added metal additives when metal additives other than aluminum and zinc are included in the magnesium alloy. (Xiao - ¶¶ 12-20, 26, 33-60; Table 1; Claims 2-3). As illustrated in the seven examples, the magnesium content of the magnesium alloy ranges from 54.2-79.2 wt.% of the magnesium alloy when metal additives other than aluminum and zinc are included in the magnesium alloy. (Xiao - Table 1).

Tables 1-2 of Xiao teach that the decomposition rate of the seven (7) magnesium alloy examples range from 0.036-0.074 g/cm²/hr. (36-74 mg/cm²/hr.). Based on the various compositions of magnesium tested, there is no indication that a decomposition rate of greater than 0.074 g/cm²/hr. can be obtained.

In summary, Xiao teaches that to form a magnesium alloy that has at least 250 MPa compressive strength (Tensile Strength) and a decomposition rate greater than 0.02 g/cm²/hr. in

3% KCl solution at 93°C, the magnesium alloy must include 13-25 wt.% aluminum, 2-15 wt.% zinc, and the balance magnesium. When only aluminum and zinc are included in the magnesium alloy, the magnesium content in the magnesium alloy is 60-85 wt.%. However, when metal additives other than aluminum and zinc are included in the magnesium alloy, the magnesium alloy includes 1) significantly less than 85 wt.% Mg, 2) an Al content of at least 13 wt.%, 3) a Zn content of at least 2 wt.%, and 4) multiple metal additives of 0.1-5 wt.% Fe, 0.05-5 wt.% Ni, 0.05-0.5 wt.% Zr, 0.05-0.5 wt.% Ti, and optionally 0.05-5 wt.% Cu and 0-5 wt.% Ag. (See Abstract; ¶¶ 12-20, 26, 33-60; Table 1; Claims 2-3).

B. Patentability of Claims

“A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.” *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987); *See also* MPEP 2131.

1. Independent Claim 1

Independent claim 1 requires a) the magnesium composite include *in situ* precipitation of galvanically-active intermetallic phases to enable controlled dissolution of the magnesium composite, and b) the additive material have a greater melting point temperature than a solidus temperature of the magnesium. Applicant submits that these limitations of claim 1 are not anticipated by nor obvious from the teachings of Xiao.

On Page 3 of the NFOA, the Examiner stated that Xiao teaches at paragraph 26 a magnesium alloy having intermetallic composites that include zinc, aluminum, copper, nickel, and silver. The Examiner also stated that paragraph 26 of Xiao teaches the matrix and the grain

boundary of the magnesium alloy form a large amount of micro-batteries that greatly accelerate the corrosion decomposition of the magnesium alloy. The Examiner further stated that claims 1-3 of Xiao directly states the magnesium alloy composition taught by Xiao.

On Page 4 of the NFOA, the Examiner referred to Table 1 of Xiao as identifying the composition of a comparative AZ91D magnesium alloy and seven (7) example magnesium alloy compositions in accordance with the teachings of Xiao. The Examiner concluded that the compositions in Table 1 anticipated the magnesium composition defined in claim 1 of the ‘795 Reexam.

On Page 5 of the NFOA, the Examiner referred to Table 2 of Xiao regarding the compressive strength (Tensile Strength) and decomposition rates of the AZ91D magnesium alloy and seven (7) example magnesium alloy compositions. The Examiner concluded that the decomposition rates in Table 2 anticipated the decomposition rate of the magnesium composite defined in claim 1 of the ‘795 Reexam.

On Page 4 of the NFOA, the Examiner stated that paragraph 108 of the Dr. Medlin Declaration establishes that Xiao teaches that the magnesium composite of Xiao includes *in situ* precipitate. In such paragraph, Dr. Medlin concluded that a person of ordinary skill in the art (“POSITA”) would have recognized from the teachings of Xiao that precipitation of galvanically-active phases in the form of micro-batteries are naturally and necessarily generated by an *in situ* reaction between magnesium and any of the additives. Applicant notes that Dr. Medlin did not provide any supporting evidence for such conclusion.

On Pages 21-22 of the Request For *Ex Parte* Reexamination Of Claims 1-5, 7-9, 11-16, 50, 52-62, 64, 66, 67, and 69-76 of U.S. Patent No. 10,329,653 (hereinafter “Request”) filed by Ecometal, Inc. (hereinafter “Requester”), Requester did not reference the Dr. Medlin Declaration

regarding the *in situ* limitation of claim 1. Requester merely concluded that, because Xiao teaches the formation of a β ($\text{Mg}_{17}\text{Al}_{12}$) phase and an eutectic phase on the grain boundary of the magnesium alloy that produces a large number of micro-batteries, such teaching of Xiao would teach a POSITA that *in situ* precipitation is formed in the magnesium alloy of Xiao. Applicant disagrees.

Applicant submits that Xiao does not teach a magnesium alloy that includes *in situ* precipitate of galvanically-active intermetallic phases to enable controlled dissolution of the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65).

Xiao only teaches “Elements such as Fe, Cu, Ni, Ag, etc., in the magnesium alloy *can form* a large number of intermetallic composite micro-particles, which *can improve* the corrosion performance of the magnesium alloy, thereby promoting the decomposition of the magnesium alloy.” (emphasis added) (Xiao - ¶ 26). There is no other teaching in Xiao regarding particles, micro-particles or intermetallic particles.

Xiao does not teach the formation of these possible intermetallic composite micro-particles by an *in situ* process. (Dr. Swanger Declaration - ¶¶ 24, 34, 37, 38, 41, 44, 45, 49-54). Xiao merely discloses a eutectic (formed during solidification) phase on the grain boundary, which is not a galvanically-active *in situ* precipitate as recited in the claims of the ‘795 Reexam. (Dr. Swanger Declaration - ¶¶ 30, 36, 37, 59, 60).

In requiring the eutectically-formed Mg-Al – Mg micro-batteries, Xiao *teaches away* from the claims of the ‘795 Reexam which requires galvanically-active *in situ* precipitates formed between the magnesium alloy and the additive material, newly formed galvanically-active intermetallic particles, or un-melted remnants of elemental secondary metal additives. (Dr. Swanger Declaration - ¶¶ 37, 54). There is no direct or inherent teaching in Xiao that iron, copper,

nickel, or silver, when added to the magnesium alloy, form *in situ* precipitate in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 34-54).

On Pages 21, 22, 27, and 28 of the Request, Requester referenced paragraphs 107-108 of the Dr. Medlin Declaration to assert that Xiao would teach a POSITA that *in situ* precipitation formed of iron, copper, nickel, or silver would be present in the magnesium composite to enable controlled dissolution of the magnesium composite. However, as discussed above, Xiao does not teach the mechanism in which such intermetallic particles can be formed.

The Mg-Al micro-batteries taught by Xiao are not disclosed as formed by *in situ* precipitate. The aluminum in the beta phase is not *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 37, 38, 49-51, 53, 54). Precipitate is first mentioned in Xiao with regard to the optional addition of iron, copper, nickel, or silver, zirconium, and titanium to the magnesium alloy. There is no teaching in Xiao that the MgAl micro-batteries form precipitate in the magnesium alloy, nor that the MgAl micro-batteries form *in situ* precipitate in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 37, 38, 49-51, 53, 54).

In summary, there is no teaching in Xiao that *in situ* precipitate is formed in the magnesium composite defined in independent claim 1 of the '795 Reexam. (Dr. Swanger Declaration - ¶¶ 34-54).

Applicant also submits that Xiao does not teach or suggest the limitation that the additive material has a greater melting point temperature than a solidus temperature of the magnesium. The Examiner did not address this limitation of claim 1. On Pages 23-25 of the Request, the Requester asserted that a POSITA would have understood, from a reading of Xiao and looking at various phase diagrams, that the additive added to the molten magnesium and aluminum mixture would have a melting point that was greater melting point temperature than a solidus temperature of the

magnesium. The Requester did not cited to the Dr. Medlin Declaration for support of this assertion. In paragraphs 112-122 of the Dr. Medlin Declaration, Dr. Medlin asserted that a POSITA would have understood, from a reading of Xiao and looking at various Al alloy phase diagrams, that the additive added to the molten magnesium and aluminum mixture would have a melting point that was greater melting point temperature than a solidus temperature of the magnesium.

The assertions by the Requester and Medlin do not account for the teaching in Xiao that the additives are added to the magnesium melt at a temperature of 700-730°C, and then the temperature is raised to 740-780°C to cause all of the additive to melt in the mixture, and then the temperature was lowered to 700-720°C for some time period prior to the casting of the magnesium alloy. (Xiao - ¶ 22). As taught in Claim 2 and the Examples 1-7 of Xiao, the additives of iron, copper, nickel, silver, titanium, and zirconium are added to the mixture and are required to be fully melted in the magnesium molten mixture. A POSITA would understand from the teachings of Xiao that these additives cannot be added in pure form, but must be added as an intermediate alloy. (Xiao - ¶¶ 23, 36, 40, 44, 48, 52, 56, 60).

In order to ensure that the additives fully melt in the magnesium mixture, a POSITA would select certain aluminum-additive mixtures that have a lower melting point. (Dr. Swanger Declaration - ¶¶ 42, 43). A POSITA would understand that such additives need to have a melting point that is substantially less than 700°C. (Xiao - ¶¶ 22-23; Dr. Swanger Declaration - ¶¶ 42, 43). Xiao teaches that the additives are not added in pure form, but as an alloy of aluminum. Based on the teachings of Xiao, a POSITA would be motivated to select an aluminum alloy that includes an additive that has a melting point of less than 700°C to ensure that such additive fully melts in the molten magnesium or magnesium alloy. (Dr. Swanger Declaration - ¶¶ 42, 43). As such, there is

no teaching or suggestion in Xiao for a POSITA to be taught or motivated use an additive that is to be added to the molten magnesium which has melting point that is greater than the solidus temperature of the magnesium.

For at least the reasons set forth above, Xiao does not anticipate or make obvious all the limitations of independent claim 1 of the '795 Reexam. Applicant also submits that claims 2-5, 7-9 and 11 which directly depend on independent claim 1 are not anticipated nor made obvious by the teachings of Xiao.

2. Dependent Claim 4

Dependent claim 4 further includes limitations that are not taught nor made obvious by the teachings of Xiao. Dependent claim 4, which depends on independent claim 1, requires the nickel to form galvanically-active *in situ* precipitate in the magnesium composite.

On Page 6 of the NFOA, the Examiner did not address the limitation of dependent claim 4 with regard to the nickel forming galvanically-active *in situ* precipitate in the magnesium composite.

Pages 30-32 of the Request that discusses claim 4, The Requester also did not address the *in situ* limitation of claim 4.

On paragraphs 137-138 of the Dr. Medlin Declaration, Dr. Medlin concludes that a POSITA would have understood that the micro-particles formed of iron, copper, nickel, and/or silver would have been formed by *in situ* precipitation.

As discussed above, Xiao does not teach that any particles in the magnesium alloy are formed by *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 34-54). The assertions by Dr. Medlin that Xiao teaches nickel *in situ* formation are not supported by the teachings of Xiao. Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium

alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy.

As such, Xiao does not teach the formation of *in situ* precipitate in the magnesium alloy, nor does Xiao teach that nickel forms *in situ* precipitate in the magnesium alloy when added to the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65).

Dependent claim 4 is also not anticipated nor made obvious by the teachings of Xiao for these additional reasons.

3. Dependent Claim 5

Dependent claim 5 further includes limitations that are not taught nor made obvious by the teachings of Xiao. Dependent claim 5, which depends on independent claim 1, requires the copper form galvanically-active *in situ* precipitate in the magnesium composite.

On Page 6 of the NFOA, the Examiner did not address the limitation of dependent claim 5 with regard to the copper forming galvanically-active *in situ* precipitate in the magnesium composite.

On Pages 33-34 of the Request, the Requester relied on paragraphs 107 and 108 of the Dr. Medlin Declaration to assert that Xiao would teach a POSITA that *in situ* precipitation formed of copper forms galvanically-active intermetallic phases or micro-batteries in the magnesium composite. Dr. Medlin concludes in paragraphs 142-143 of the Dr. Medlin Declaration that a

POSITA would have understood that the micro-particles formed of iron, copper, nickel, and/or silver would have been formed by *in situ* precipitation.

As discussed above, Xiao does not teach that any particles in the magnesium alloy are formed by *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 34-54). The assertions of Requester and Dr. Medlin that Xiao teaches copper *in situ* formation are not supported by the teachings of Xiao. Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy.

As such, Xiao does not teach the formation of *in situ* precipitate in the magnesium alloy, nor does Xiao teach that copper forms *in situ* precipitate in the magnesium alloy when added to the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65).

Dependent claim 5 is also not anticipated nor made obvious by the teachings of Xiao for these additional reasons.

4. Independent Claim 29

Independent claim 29 requires about 0.05-45 wt.% of a secondary metal to form a galvanically-active intermetallic particle that promotes corrosion of the dissolvable magnesium alloy composite, and that the secondary metal includes one or more metals selected from the group consisting of copper, nickel, cobalt, titanium, and iron. Applicant submits that this limitation of claim 29 is not anticipated by nor obvious from the teachings of Xiao.

On Page 6 of the NFOA, the Examiner stated that claims 2-3 and the Examples of Xiao teach the limitations of claim 29. The Examiner relied upon paragraph 149 of the Dr. Medlin Declaration for support of this assertion. The Examiner also stated the additive compositional ranges of claim 29 are taught by Xiao and that Examples 1-7 of Xiao teach greater decomposition rates than required in claim 29.

On Pages 37-38 of the Request, Requester asserted that Xiao teaches a secondary metal that forms a galvanically-active intermetallic particle that promotes corrosion. The Requester did not rely on statements from Dr. Medlin for support for this assertion. In paragraphs 155-156 of the Dr. Medlin Declaration, Dr. Medlin asserted that Xiao teaches the formation of intermetallic particles that include iron, copper, nickel, and silver and then concluded that such intermetallic particles are galvanically-active intermetallic particles that promote corrosion.

The teaching of galvanically-active intermetallic particle formation is absent from Xiao. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65). The corrosion mechanism taught in Xiao is limited to the micro-batteries of MgAl formed in the magnesium alloy due to the high concentration of aluminum (e.g., at least 13 wt.% aluminum) in the magnesium alloy. Xiao teaches that these micro-batteries are the principal driver for decomposition in the magnesium alloy. There is no teaching that iron, copper, nickel, and/or silver forms micro-batteries in the magnesium alloy. Xiao only teaches that iron, copper, nickel, and/or silver can, but do not, form intermetallic composite micro-particles that promote the decomposition of the magnesium alloy. Xiao does not teach how such intermetallic composite micro-particles, when formed, promote corrosion. As such, the promotion of corrosion by such micro-particles can be by a mechanism other than galvanic action, such as i) promote different grain boundary morphology, ii) induce porosity in the

magnesium alloy, iii) increase electrochemical potential difference between phases in the magnesium alloy, etc. (Dr. Swanger Declaration - ¶ 53).

For at least the reasons set forth above, Xiao does not anticipate nor make obvious all of the limitations of independent claim 29. Applicant also submits that claims 30-32 which directly depend on independent claim 29 are not anticipated nor made obvious by the teachings of Xiao.

5. Dependent Claim 31

Dependent claim 31 further includes limitations that are not taught nor made obvious by the teachings of Xiao. Dependent claim 31, which depends on independent claim 29, requires the nickel form galvanically-active *in situ* precipitate in the magnesium composite.

On Page 7 of the NFOA, the Examiner did not address the limitation of dependent claim 31 with regard to the nickel forming galvanically-active *in situ* precipitate in the magnesium composite.

On Pages 40-41 of the Request, the Requester relied on paragraphs 107 and 108 of the Dr. Medlin Declaration to assert that Xiao would teach a POSITA that *in situ* precipitation formed of nickel forms galvanically-active intermetallic phases or micro-batteries in the magnesium composite. Applicant notes that the Dr. Medlin Declaration is absent any discussion regarding the patentability of claim 31.

As stated above, Xiao does not teach that any particles in the magnesium alloy are formed by *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 34-54). The assertions by Requester that Xiao teaches nickel *in situ* formation are not supported by the teachings of Xiao. Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion

performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy.

As such, Xiao does not teach the formation of *in situ* precipitate in the magnesium alloy, nor does Xiao teach that nickel forms *in situ* precipitate in the magnesium alloy when added to the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65).

Dependent claim 31 is also not anticipated nor made obvious by the teachings of Xiao for these additional reasons.

6. Independent Claim 37

Independent claim 37 requires about 0.05-45 wt.% of a secondary metal to form a galvanically-active intermetallic particle that promotes corrosion of the dissolvable magnesium alloy composite, and wherein the secondary metal includes one or more metals selected from the group consisting of copper, nickel, cobalt, titanium, and iron. Applicant submits that these limitations of claim 37 are not anticipated by nor obvious from the teachings of Xiao.

On Page 7 of the NFOA, the Examiner stated that claims 2-3 and several examples of Xiao teach the limitations of claim 37. The Examiner relied upon paragraphs 166-168 of the Dr. Medlin Declaration for support of this assertion. The Examiner also stated that several of the Examples of Xiao teach greater decomposition rates than required in claim 37.

On Page 44 of the Request, Requester asserted that Xiao teaches a secondary metal that forms a galvanically-active intermetallic particle that promotes corrosion. Requester relied on paragraphs 107-108 of the Dr. Medlin Declaration for support for this assertion. In paragraphs 170-171 of the Dr. Medlin Declaration, Dr. Medlin asserted that Xiao teaches the formation of

intermetallic particles that include iron, copper, nickel, and silver, and then concluded that such intermetallic particles are galvanically-active intermetallic particles that promotes corrosion.

As stated above with respect to claim 29, the teaching of galvanically-active intermetallic particle formation is absent from Xiao. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65). The corrosion mechanism taught in Xiao is limited to the micro-batteries of MgAl formed in the magnesium alloy due to the high concentration of aluminum (e.g., at least 13 wt.% aluminum) in the magnesium alloy. Xiao teaches that these micro-batteries are the principal driver for decomposition in the magnesium alloy. There is no teaching that iron, copper, nickel, and/or silver form micro-batteries in the magnesium alloy. Xiao only teaches that iron, copper, nickel, and/or silver can, but is not required to, form intermetallic composite micro-particles that promote the decomposition of the magnesium alloy. Xiao does not teach how such intermetallic composite micro-particles, when formed, promote corrosion. As such, the promotion of corrosion by such micro-particles can be by a mechanism other than galvanic action, such as i) promote different grain boundary morphology, ii) induce porosity in the magnesium alloy, iii) increase electrochemical potential difference between phases in the magnesium alloy, etc. (Dr. Swanger Declaration - ¶ 53).

For at least the reasons set forth above, Xiao does not anticipate nor make obvious all of the limitations of independent claim 37. Applicant also submits that claims 38-40 which directly depend on independent claim 37 are not anticipated nor made obvious by the teachings of Xiao.

7. Dependent Claim 39

Dependent claim 39 further includes limitations that are not taught nor made obvious by the teachings of Xiao. Dependent claim 39, which depends on independent claim 37, requires that the nickel form galvanically-active *in situ* precipitate in the magnesium composite.

On Page 7 of the NFOA, the Examiner did not address the limitation of dependent claim 39 with regard to the nickel forming galvanically-active *in situ* precipitate in the magnesium composite.

On Pages 47-48 of the Request, Requester relied on paragraphs 107 and 108 of the Dr. Medlin Declaration to assert that Xiao would teach a POSITA that *in situ* precipitation formed of nickel forms galvanically-active intermetallic phases or micro-batteries in the magnesium composite. Applicant notes that the Dr. Medlin Declaration is absent any discussion regarding the patentability of claim 39.

As stated above, Xiao does not teach that any particles in the magnesium alloy are formed by *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 34-54). The assertions by Requester that Xiao teaches nickel *in situ* formation are not supported by the teachings of Xiao. Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy.

As such, Xiao does not teach the formation of *in situ* precipitate in the magnesium alloy, nor does Xiao teach that nickel forms *in situ* precipitate in the magnesium alloy when added to the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 24, 34-54 65).

Dependent claim 39 is also not anticipated nor made obvious by the teachings of Xiao for these additional reasons.

8. Independent Claim 41

Independent claim 41 requires about 0.05-45 wt.% of a secondary metal to form a galvanically-active intermetallic particle that promotes corrosion of the dissolvable magnesium alloy composite, and wherein the secondary metal includes one or more metals selected from the group consisting of copper, nickel, and cobalt. Applicant submits that these limitations of claim 41 are not anticipated by nor obvious from the teachings of Xiao.

On Page 7-8 of the NFOA, the Examiner stated that claims 2-3 and the Examples of Xiao teach the limitations of claim 41. The Examiner relied upon paragraphs 181-186 of the Dr. Medlin Declaration for support of this assertion. The Examiner also stated Xiao teaches the additive compositional ranges of claim 41 and that Examples 1-7 of Xiao teach greater decomposition rates than required in claim 41.

On Pages 51-52 of the Request, Requester asserted that Xiao teaches a secondary metal that forms a galvanically-active intermetallic particle that promotes corrosion. Requester relied on paragraphs 107-108 of the Dr. Medlin Declaration for support for this assertion. Dr. Medlin in paragraphs 187-188 asserted that Xiao teaches the formation of intermetallic particles that include iron, copper, nickel, and silver, and then concluded that such intermetallic particles are galvanically-active intermetallic particles that promotes corrosion.

As stated above with respect to claims 29 and 33, the teaching of galvanically-active intermetallic particle formation is absent from Xiao. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65). The corrosion mechanism taught in Xiao is limited to the micro-batteries of MgAl formed in the magnesium alloy due to the high concentration of aluminum (e.g., at least 13 wt.% aluminum) in the magnesium alloy. Xiao teaches that these micro-batteries are the principal driver for decomposition in the magnesium alloy. There is no teaching that iron, copper, nickel, and/or silver

forms micro-batteries in the magnesium alloy. Xiao only teaches that iron, copper, nickel, and/or silver can, but are required to, form intermetallic composite micro-particles that promote the decomposition of the magnesium alloy. Xiao does not teach how such intermetallic composite micro-particles, when formed, promote corrosion. As such, the promotion of corrosion by such micro-particles can be by a mechanism other than galvanic action, such as i) promote different grain boundary morphology, ii) induce porosity in the magnesium alloy, iii) increase electrochemical potential difference between phases in the magnesium alloy, etc. (Dr. Swanger Declaration - ¶ 53).

For at least the reasons set forth above, Xiao does not anticipate nor make obvious all of the limitations of independent claim 41. Applicant also submits that claims 42-44 which directly depend on independent claim 41 are not anticipated nor made obvious by the teachings of Xiao.

9. Dependent Claim 43

Dependent claim 43 further includes limitations that are not taught nor made obvious by the teachings of Xiao. Dependent claim 43, which depends on independent claim 41, requires the nickel form galvanically-active *in situ* precipitate in the magnesium composite.

On Page 8 of the NFOA, the Examiner did not address the limitation of dependent claim 39 with regard to the nickel forming galvanically-active *in situ* precipitate in the magnesium composite.

On Pages 54-55 of the Request, Requester relied on paragraphs 107 and 108 of the Dr. Medlin Declaration to assert that Xiao would teach a POSITA that *in situ* precipitation formed of nickel forms galvanically-active intermetallic phases or micro-batteries in the magnesium composite. Applicant notes that Paragraphs 197-198 of the Dr. Medlin Declaration conclude that

a POSITA would have understood that the micro-particles formed of iron, copper, nickel, and/or silver would have been formed by *in situ* precipitation.

As stated above, Xiao does not teach that any particles in the magnesium alloy are formed by *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 34-54). The assertions by Requester that Xiao teaches nickel *in situ* formation are not supported by the teachings of Xiao. Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy.

As such, Xiao does not teach the formation of *in situ* precipitate in the magnesium alloy, nor does Xiao teach that nickel forms *in situ* precipitate in the magnesium alloy when added to the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65).

Dependent claim 43 is also not anticipated nor made obvious by the teachings of Xiao for these additional reasons.

10. Independent Claim 45

Independent claim 45 requires about 0.05-45 wt.% of a secondary metal to form a galvanically-active intermetallic particle that promotes corrosion of the dissolvable magnesium alloy composite, and wherein the secondary metal includes one or more metals selected from the group consisting of copper, nickel, and cobalt. Applicant submits that this limitation of claim 45 is not anticipated by nor obvious from the teachings of Xiao.

On Page 8-9 of the NFOA, the Examiner stated that claims 2-3 and the Examples of Xiao teach the limitations of claim 45. The Examiner also stated that Xiao teaches the additive compositional ranges of claim 45 and that Examples 1-7 of Xiao teach greater decomposition rates than required in claim 45.

On Pages 57-59 of the Request, Requester asserted that Xiao teaches a secondary metal that forms a galvanically-active intermetallic particle that promotes corrosion. Requester did not rely on the Dr. Medlin Declaration for support for this assertion. Dr. Medlin in paragraphs 206-207 asserted that Xiao teaches the formation of intermetallic particles that include iron, copper, nickel, and silver, and then concluded that such intermetallic particles are galvanically-active intermetallic particles that promotes corrosion.

As stated above with respect to claims 29, 33, 41 and 45, the teaching of galvanically-active intermetallic particle formation is absent from Xiao. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65). The corrosion mechanism taught in Xiao is limited to the micro-batteries of MgAl formed in the magnesium alloy due to the high concentration of aluminum (e.g., at least 13 wt.% aluminum) in the magnesium alloy. Xiao teaches that these micro-batteries are the principal driver for decomposition in the magnesium alloy. There is no teaching that iron, copper, nickel, and/or silver form micro-batteries in the magnesium alloy. Xiao only teaches that iron, copper, nickel, and/or silver can, but are not required to, form intermetallic composite micro-particles that promote the decomposition of the magnesium alloy. Xiao does not teach how such intermetallic composite micro-particles, when formed, promote corrosion. As such, the promotion of corrosion by such micro-particles can be by a mechanism other than galvanic action, such as i) promote different grain boundary morphology, ii) induce porosity in the magnesium alloy, iii) increase

electrochemical potential difference between phases in the magnesium alloy, etc. (Dr. Swanger Declaration - ¶ 53).

For at least the reasons set forth above, Xiao does not anticipate all of the limitations of independent claim 45. Applicant also submits that claims 46-48 which directly depend on independent claim 45 are not anticipated by Xiao.

11. Dependent Claim 47

Dependent claim 47 further includes limitations that are not taught nor made obvious by the teachings of Xiao. Dependent claim 47, which depends on independent claim 45, requires that the nickel form galvanically-active *in situ* precipitate in the magnesium composite.

On Page 9 of the NFOA, the Examiner did not address the limitation of dependent claim 47 with regard to the nickel forming galvanically-active *in situ* precipitate in the magnesium composite.

On Pages 61-62 of the Request, Requester relied on paragraphs 107 and 108 of the Dr. Medlin Declaration to assert that Xiao would teach a POSITA that *in situ* precipitation formed of nickel forms galvanically-active intermetallic phases or micro-batteries in the magnesium composite. Applicant notes that the Dr. Medlin Declaration is absent any discussion regarding the patentability of claim 47.

As stated above, Xiao does not teach that any particles in the magnesium alloy are formed by *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 34-54). The assertions by Requester that Xiao teaches nickel *in situ* formation are not supported by the teachings of Xiao. Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion

performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy.

As such, Xiao does not teach the formation of *in situ* precipitate in the magnesium alloy, nor does Xiao teach that nickel forms *in situ* precipitate in the magnesium alloy when added to the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65).

Dependent claim 47 is also not anticipated nor made obvious by the teachings of Xiao for these additional reasons.

12. Independent Claim 49

Independent claim 49 requires a) a magnesium composite that includes *in situ* precipitation of galvanically-active intermetallic phases to enable controlled dissolution of the magnesium composite, b) the magnesium composite comprises a mixture of magnesium or a magnesium alloy and an additive material, and wherein the additive material includes one or more metals selected from the group consisting of copper, nickel, titanium, iron, and cobalt, and c) the magnesium composite includes *in situ* precipitation of galvanically-active intermetallic phases that include the additive material. Applicant submits that these limitations of claim 49 are not anticipated by nor obvious from the teachings of Xiao.

On Page 9 of the NFOA, the Examiner asserted that claims 2-3 and the Examples of Xiao teach the limitations of claim 49. The Examiner also stated that Examples 1-7 of Xiao teach greater decomposition rates than required in claim 49. The Examiner did not address the two *in situ* limitations of claim 49.

On Page 63 of the Request, Requester referenced paragraphs 107 and 108 of the Dr. Medlin Declaration to assert that Xiao would teach a POSITA that *in situ* precipitation is formed in the magnesium alloy of Xiao. In paragraphs 216-218 of the Dr. Medlin Declaration, Dr. Medlin also concluded that Xiao teaches a POSITA that *in situ* precipitate is formed in the Xiao magnesium alloy.

As discussed above with regard to independent claim 1, Xiao does not teach a magnesium alloy that includes *in situ* precipitate of galvanically-active intermetallic phases to enable controlled dissolution of the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65).

Xiao only teaches “Elements such as Fe, Cu, Ni, Ag, etc., in the magnesium alloy *can form* a large number of intermetallic composite micro-particles, which *can improve* the corrosion performance of the magnesium alloy, thereby promoting the decomposition of the magnesium alloy.” (emphasis added) (Xiao - ¶26). There is no other teaching in Xiao regarding particles, micro-particles, or intermetallic particles.

Xiao does not teach the formation of these possible intermetallic composite micro-particles by an *in situ* process. (Dr. Swanger Declaration - ¶¶ 24, 34, 37, 38, 41, 44, 45, 49-54). Xiao merely discloses a eutectic (formed during solidification) phase on the grain boundary, which is not a galvanically-active *in situ* precipitate as recited in the claims of the ‘795 Reexam. (Dr. Swanger Declaration - ¶¶ 37, 59, 60). In requiring the eutectically-formed Mg-Al – Mg micro-batteries, Xiao *teaches away* from the claims of the ‘795 Reexam which require galvanically-active *in situ* precipitates formed between the magnesium alloy and the additive material, newly formed galvanically-active intermetallic particles, or un-melted remnants of elemental secondary metal additives. (Dr. Swanger Declaration - ¶¶ 37, 59, 60). There is no direct or inherent teaching in

Xiao that iron, copper, nickel, and silver, when added to the magnesium alloy, form *in situ* precipitate in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 34-54).

On Pages 65-66 of the Request, Requester relied on paragraph 256 of the Dr. Medlin Declaration to assert that Xiao teaches that additive material is included in the *in situ* precipitate. In paragraphs 226-227 of the Dr. Medlin Declaration, Dr. Medlin concluded that Xiao would teach a POSITA that *in situ* precipitation formed of iron, copper, nickel, and/or silver forms galvanically-active intermetallic phases or “micro-batteries in the magnesium composite.

As discussed above, the Mg-Al micro-batteries taught by Xiao are not disclosed as formed by *in situ* precipitate. The aluminum in the beta phase is not *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 37, 38, 49-51, 53, 54). Precipitate is first mentioned in Xiao with regard to the optional addition of iron, copper, nickel, silver, zirconium, and titanium to the magnesium alloy. There is no teaching in Xiao that the MgAl micro-batteries form precipitate in the magnesium alloy, nor that the MgAl micro-batteries form *in situ* precipitate in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 37, 38, 49-51, 53, 54). Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy. Xiao does not teach a magnesium alloy that includes *in situ* precipitation, nor that any precipitate of iron, copper, nickel, and silver is *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 34-54).

For at least the reasons set forth above, Xiao does not anticipate or make obvious all of the limitations of independent claim 49. Applicant also submits that claims 50, 52-62, 64, 66, 67, and 69-72 which directly or indirectly depend on independent claim 49 are not anticipated or made obvious by the teachings of Xiao.

13. Dependent Claim 61

Dependent claim 61 further includes limitations that are not taught nor made obvious by the teachings of Xiao. Dependent claim 61, which depends on independent claim 49, requires that the nickel form galvanically-active *in situ* precipitate in the magnesium composite.

On Page 10 of the NFOA, the Examiner did not address the limitation of dependent claim 61 with regard to the nickel forming galvanically-active *in situ* precipitate in the magnesium composite.

On Pages 78-79 of the Request, Requester relied on paragraphs 107 and 108 of the Dr. Medlin Declaration to assert that Xiao would teach a POSITA that *in situ* precipitation formed of nickel forms galvanically-active intermetallic phases or “micro-batteries in the magnesium composite. Applicant notes that the Dr. Medlin Declaration is absent any discussion regarding the patentability of claim 61.

As stated above, Xiao does not teach that any particles in the magnesium alloy are formed by *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 34-54). The assertions by Requester that Xiao teaches nickel *in situ* formation are not supported by the teachings of Xiao. Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion

performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy.

As such, Xiao does not teach the formation of *in situ* precipitate in the magnesium alloy, nor does Xiao teach that nickel forms *in situ* precipitate in the magnesium alloy when added to the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65).

Dependent claim 61 is also not anticipated nor made obvious by the teachings of Xiao for these additional reasons.

14. Dependent Claim 64

Dependent claim 64 further includes limitations that are not taught nor made obvious by the teachings of Xiao. Dependent claim 64, which depends on independent claim 49, requires that the copper form galvanically-active *in situ* precipitate in the magnesium composite.

On Page 11 of the NFOA, the Examiner did not address the limitation of dependent claim 64 with regard to the copper forming galvanically-active *in situ* precipitate in the magnesium composite.

On Pages 82-83 of the Request, the Requester asserted that Xiao would teaches that *in situ* precipitation formed of copper forms galvanically-active intermetallic phases or micro-batteries in the magnesium composite. Requester did not cite to any paragraph of the Dr. Medlin Declaration for support of such teaching in Xiao. Applicant notes that the Dr. Medlin Declaration is absent any discussion regarding the patentability of claim 64.

As stated above, Xiao does not teach that any particles in the magnesium alloy are formed by *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 34-54). The assertions by Requester that Xiao teaches nickel *in situ* formation are not supported by the teachings of Xiao. Xiao only teaches that

magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy.

As such, Xiao does not teach the formation of *in situ* precipitate in the magnesium alloy, nor does Xiao teach that copper forms *in situ* precipitate in the magnesium alloy when added to the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65).

Dependent claim 64 is also not anticipated nor made obvious by the teachings of Xiao for these additional reasons.

15. Dependent Claim 69

Dependent claim 69 further includes limitations that are not taught nor made obvious by the teachings of Xiao. Dependent claim 69, which depends on independent claim 49, requires that the additive material have a melting point temperature that is 100°C greater than a melting temperature of the magnesium or magnesium alloy.

On Page 11 of the NFOA, the Examiner stated that because melting point information is readily accessible and Xiao's alloys are the same as the claimed alloys, Xiao's intermediate alloys would necessarily have melting point temperatures 100°C greater than the melting temperatures of magnesium. The Examiner did not discuss the melting point of the Al alloys including additives taught by Xiao. On Pages 84-86 of the Request, the Requester relied on paragraphs 50-52, 235, 239 and 240 of the Dr. Medlin Declaration to assert that a POSITA would have selected

additives to add to the molten magnesium mixture that had a melting point temperature of 100°C greater than the melting temperature of magnesium or magnesium alloy.

As stated above, with regard to claim 1, the assertions by the Examiner, Requester, and Medlin do not account for the teaching in Xiao that the additives are added to the magnesium melt at a temperature of 700-730°C, and then the temperature is raised to 740-780°C to cause all of the additive to melt in the mixture, and then the temperature was lowered to 700-720°C for some time period prior to the casting of the magnesium alloy. (Xiao - ¶ 22). As taught in Claim 2 and the Examples 1-7 of Xiao, the additives of iron, copper, nickel, silver, titanium, and zirconium are added to the mixture and are required to be fully melted in the magnesium molten mixture. A POSITA would understand from the teachings of Xiao that these additives cannot be added in pure form, but must be added as an intermediate alloy. (Xiao - ¶¶ 23, 36, 40, 44, 48, 52, 56, 60).

In order to ensure that the additives fully melt in the magnesium mixture, a POSITA would select certain aluminum-additive mixtures that have a lower melting point. (Dr. Swanger Declaration - ¶¶ 42, 43). A POSITA would understand that such additives will have a melting point that is substantially less than 700°C. (Xiao - ¶¶ 22-23; Dr. Swanger Declaration - ¶¶ 42, 43). Xiao teaches that the additives are not added in pure form, but as an alloy of aluminum. There is no teaching or suggestion in Xiao that a POSITA would be motivated to select an alloy of aluminum that has a melting point of greater than 100°C the melting point of magnesium or magnesium alloy as defined in claim 69. Based on the teachings of Xiao, a POSITA would be motivated to select an aluminum alloy that includes an additive that has a melting point of less than 700°C to ensure that such additive fully melts in the molten magnesium or magnesium alloy. (Dr. Swanger Declaration - ¶¶ 42, 43). As such, there is no teaching or suggestion in Xiao for a POSITA to be taught or motivated use an additive that is to be added to the molten magnesium

which has melting point that is greater than 100°C the melting point of magnesium or magnesium alloy.

Dependent claim 69 is also not anticipated nor made obvious by the teachings of Xiao for these additional reasons.

16. Independent Claim 73

Independent claim 73 requires a) the dissolvable magnesium composite includes *in situ* precipitation of galvanically-active intermetallic phases to enable controlled dissolution of the magnesium composite, b) the magnesium composite comprises a mixture of magnesium or a magnesium alloy and an additive material, and wherein the additive material includes one or more metals selected from the group consisting of copper, nickel, titanium, iron, silicon, and cobalt, and c) the magnesium composite includes *in situ* precipitation of galvanically-active intermetallic phases that include the additive material. Applicant submits that these limitations of claim 73 are not anticipated by nor obvious from the teachings of Xiao.

On Page 12 of the NFOA, the Examiner asserted that all of the limitations of claim 73 were taught by Xiao. The Examiner asserted that claims 2-3 and the Examples of Xiao teach the limitations of claim 73. The Examiner also stated that Examples 1-7 of Xiao teach greater decomposition rates than required in claim 73. The Examiner did not address the two *in situ* limitations of claim 73.

On Page 88 of the Request, Requester referenced paragraphs 107 and 108 of the Dr. Medlin Declaration to assert that Xiao would teach a POSITA that *in situ* precipitation is formed in the magnesium alloy of Xiao. In paragraphs 247-249 of the Dr. Medlin Declaration, Dr. Medlin also concluded that Xiao teaches a POSITA that *in situ* precipitate is formed in the Xiao magnesium alloy.

As stated above with regard to independent claims 1 and 49, Applicant submits that Xiao does not teach a magnesium alloy that includes *in situ* precipitate of galvanically-active intermetallic phases to enable controlled dissolution of the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 34-54).

Xiao only teaches “Elements such as iron, copper, nickel, silver, etc., in the magnesium alloy *can form* a large number of intermetallic composite micro-particles, which *can improve* the corrosion performance of the magnesium alloy, thereby promoting the decomposition of the magnesium alloy.” (emphasis added) (Xiao - ¶ 26). There is no other teaching in Xiao regarding particles, micro-particles, or intermetallic particles.

Xiao does not teach the formation of these possible intermetallic composite micro-particles by an *in situ* process. (Dr. Swanger Declaration - ¶¶ 24, 34, 37, 38, 41, 44, 45, 49-54). Xiao merely discloses a eutectic (formed during solidification) phase on the grain boundary, which is not a galvanically-active *in situ* precipitate as recited in the claims of the ‘795 Reexam. (Dr. Swanger Declaration - ¶¶ 37, 59, 60). In requiring the eutectically-formed Mg-Al – Mg micro-batteries, Xiao *teaches away* from the claims of the ‘795 Reexam which require galvanically-active *in situ* precipitates formed between the magnesium alloy and the additive material, newly formed galvanically-active intermetallic particles, or un-melted remnants of elemental secondary metal additives. (Dr. Swanger Declaration - ¶¶ 37, 59, 60). There is no direct or inherent teaching in Xiao that iron, copper, nickel, and silver, when added to the magnesium alloy, form *in situ* precipitate in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 34-54).

On Page 91 of the Request, Requester relied on paragraph 256 of the Dr. Medlin Declaration to assert that Xiao teaches that additive material is included in the *in situ* precipitate. Dr. Medlin concluded in such paragraph that Xiao would teach a POSITA that *in situ* precipitation

formed of iron, copper, nickel, and/or silver forms galvanically-active intermetallic phases or micro-batteries in the magnesium composite.

As discussed above, the Mg-Al micro-batteries taught by Xiao are not disclosed as formed by *in situ* precipitate. The aluminum in the beta phase is not *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 37, 38, 49-51, 53, 54). Precipitate is first mentioned in Xiao with regard to the optional addition of iron, copper, nickel, silver, zirconium, and titanium to the magnesium alloy. There is no teaching in Xiao that the MgAl micro-batteries form precipitate in the magnesium alloy, nor that the MgAl micro-batteries form *in situ* precipitate in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 37, 38, 49, 54). Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy. Xiao does not teach a magnesium alloy that includes *in situ* precipitation, nor that any precipitate of iron, copper, nickel, and silver is *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65).

For at least the reasons set forth above, Xiao does not anticipate or make obvious all of the limitations of independent claim 73.

Legal precedent requires a withdrawal of the rejection to claims 1-5, 9, 11, 29-32, 37-50, 52-54, 56, 57, 59-62, 64, 66, 67, 69, 70, 72 and 73 of the '795 Reexam under 35 U.S.C. §102(a)(1). Notice of the same is respectfully requested.

III. 35 U.S.C. 103

Claims 8, 25-28, 33-36, 55, 58 and 74-76 of the '795 Reexam are rejected under U.S.C. 103(a) as being unpatentable over Xiao.

Claims 7, 12-16, 18-21, 23, 24 and 71 are rejected under U.S.C. 103(a) as being unpatentable over Xiao in view of *Development of High Strength Magnesium Based Composites Using Elemental Nickel Particulates as Reinforcement*, Hassan, S.F., Gupta, M, Journal of Materials Science vol. 37, pp. 2467-2474 (2002) (hereinafter "Hassan").

To reject claims under 35 U.S.C. §103, there must be a showing of an unrebutted prima facie case of obviousness. *In re Deuel*, 34 USPQ2d 1210, 1214 (Fed. Cir. 1995). In the absence of a proper prima facie case of obviousness, an inventor who complies with the other statutory requirements is entitled to a patent. *Oetiker*, 24 USPQ2d at 1444.

Section 103 specifically requires consideration of the claimed invention "as a whole." *Ruiz v. A.B. Chance Co.*, 69 USPQ2d 1686, 1690 (Fed. Cir. 2004). Inventions typically are new combinations of existing principles or features. *Envtl. Designs, Ltd. v. Union Oil Co.*, 713 F.2d 693, 698 (Fed. Cir. 1983) (noting that "virtually all [inventions] are combinations of old elements."). As such, most, if not all, inventions arise from a combination of old elements. *In re Rouffet*, 47 USPQ2d 1453, 1457 (Fed. Cir. 1998). Consequently, identification in the prior art of each individual part claimed is insufficient to defeat patentability of the whole claimed invention. *Id.* The "as a whole" instruction in Title 35 prevents evaluation of the invention part by part. *Ruiz*, 69 USPQ at 1690. Without this important requirement, an obviousness assessment might break an invention into its component parts (A + B + C), then find a prior art reference containing A, another containing B, and another containing C, and on that basis alone declare the invention obvious. *Id.* This form of hindsight reasoning, using the invention as a roadmap to find its prior art

components, would discount the value of combining various existing features or principles in a new way to achieve a new result--often the very definition of invention. *Id.* Section 103 requires that there be some “articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *KSR International Co. v. Teleflex Inc.*, 82 USPQ2d 1385 (2007).

An obviousness determination requires consideration of: (1) the scope and content of the prior art; (2) the differences between the prior art and claims at issue; (3) the level of ordinary skill in the art; and (4) any objective evidence bearing on patentability, including commercial success, failure of others, and long-felt but unsolved needs. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966). Obviousness must be measured as of the time the invention was made and without the benefit of hindsight. *Panduit Corp. v. Dennison Mfg. Co.*, 774 F.2d 1082, 1092 (Fed. Cir. 1985), vacated on other grounds, 475 U.S. 809 (1986).

Section 103 precludes this hindsight discounting of the value of new combinations by requiring assessment of the invention as a whole. *Ruiz*, 69 USPQ at 1690. A rejection under Section 103 also requires a showing that an artisan of ordinary skill in the art at the time of invention, confronted by the same problems as the inventor and with no knowledge of the claimed invention, would select the various elements from the prior art and combine them in the claimed manner. *Id.* Without such teachings, the claims pending in the patent application cannot be shown to be invalid for obviousness.

A critical step in analyzing the patentability of claims pursuant to 35 U.S.C. §103(a) is casting the mind back to the time of invention, to consider the thinking of one of ordinary skill in the art, guided only by the prior art references and the then-accepted wisdom in the field. *Dembiczak*, 50 USPQ2d at 1617. When the art in question is relatively simple, the opportunity to judge by hindsight is particularly tempting. Close adherence to this methodology is especially

important in cases where the very ease with which the invention can be understood may prompt one “to fall victim to the insidious effect of a hindsight syndrome wherein that which only the invention taught is used against its teacher.” *Id.*

Irrespective of whether express or implicit showings are relied upon to reject claims under Section 103, there must be provided particular findings related thereto. *Dembiczak*, 50 USPQ2d at 1617. Broad conclusory statements standing alone are not “evidence” of obviousness. *Id.*, See also *McElmurry v. Arkansas Power & Light Co.*, 27 USPQ2d 1129, 1131 (Fed. Cir. 1993); *In re Sichert*, 196 USPQ 209, 217 (CCPA 1977).

As discussed below, none of the claims of the ‘795 Reexam are obvious in view of the teachings of Xiao, or obvious in view of the combined teachings of Xiao and Hassan.

A. Patentability of Claims in View of Xiao

On Pages 13-17 of the NFOA, the Examiner asserted that claims 8, 25-28, 33-36, 55, 58 and 74-76 of the ‘795 Reexam were rejected under U.S.C. 103(a) as being unpatentable over Xiao.

1. Dependent Claim 8

Dependent claim 8 further includes limitations that are not taught nor made obvious by the teachings of Xiao. Dependent claim 8, which depends on independent claim 1, requires the magnesium composite be subjected to a surface treatment to improve a surface hardness of the magnesium composite, and wherein the surface treatment includes peening, heat treatment, and/or aluminizing.

On Page 13 of the NFOA, the Examiner acknowledged that Xiao does not teach a surface treatment to surface harden the magnesium alloy. Instead, the Examiner relied on the teachings of US 2011/0132143 (“Xu”) identified in the background of Xiao for teachings regarding

electroplating and sintering. The Examiner concluded that electroplating and sintering processes are the same or similar to the surface treatment processes of peening, heat treatment, and/or aluminizing as defined in claim 8.

Xu teaches a metallic powder 10 that includes a plurality of metallic, coated powder particles 12 that can be sintered to form a lightweight, high-strength powder compact 200 having selectable and controllable dissolution characteristics. (Xu - ¶¶ 42, 43). Suitable core materials for the coated power particles include magnesium, aluminum, manganese and/or zinc. (Xu - ¶ 43). Metallic coating layer 16 may include a single layer, as illustrated in FIG. 2, or a plurality of layers as a multilayer coating structure, as illustrated in FIGS. 3-5 for up to four layers. (Xu - ¶ 49). Xu teaches that powder 10 is configured for compaction and sintering to form a powder compact 200. (Xu - ¶ 63). Xu does not teach any type of surface treatment for the powder compact. Xu does not teaching that the coated particles are coated to increase the surface hardness of the final formed powder compact. The particles are coated so as to bond the particles together to form the powder compact.

The Examiner relied upon paragraphs 267 and 268 of the Dr. Medlin Declaration regarding the teachings of Xu. On Pages 94-96 of the Request, Requester also cited to the teachings of Xu as support for asserting that the limitations of claim 8 are taught or obvious from such teachings of Xu. Requester did not cite to any portion of the Dr. Medlin Declaration regarding the teachings of Xu as to the limitations of claim 8.

Dr. Medlin asserted in paragraphs 267 and 268 of the Dr. Medlin Declaration that Xu teaches a decomposable multilayered coated core-shell structure wherein the sintering process is a type of surface treatment to improve the surface hardness of the powder compart. A similar assertion was made by Requester. Applicant submits that Examiner's, Requester's and Dr.

Medlin's reliance on Xu for teachings related to the limitations of claim 8 are not supported by the teachings of Xu.

As stated above, Xu teaches coated particles sintered together to form a powder compact that is formed into a final tool. The sintering process used to form the powder compact, does not modify the powder compact after the powder compact is formed. The sintering process of Xu is a completely different composite forming process from what is taught by Xiao.

Xiao teaches a casting process that melts all of the alloy components prior to forming the final alloy so that all of the alloy components are homogeneously mixed together. A sintering process mixes together a plurality of particles and only heats the particles for a limited time period such that only the outer surface of the particles bond together. A sintering process does not result in the particles being fully melted. A POSITA would know that sintering is a thermal process causing particles of metal powder pressed together at low temperature to bond to each other by atomic diffusion at temperatures below the melting point of the metal powder. (Dr. Swanger Declaration - ¶ 58).

Further, Xu does not teach that the sintering process is used for any purpose other than consolidating the coated particles into a powder compact. The sintering process is taught only as a particle consolidation process, not a surface hardening process as represented by Dr. Medlin. Indeed, there is no teaching in Xu that the sintering process results in a final powder compact that has a surface hardness that is greater than the surface hardness of the coated particles prior to the consolidation and sintering process. A POSITA would know that sintering is not a surface hardening treatment and is in no way related to true surface hardening treatments such as carburizing, nitriding, flame hardening, or induction hardening. (Dr. Swanger Declaration - ¶ 58). Applicant submits that neither Xiao nor Xu teach any type of surface hardening process.

Furthermore, neither Xiao nor Xu teach the specific surface hardening processes defined in claim 8. The sintering process taught by Xu is not a peening process (e.g., the process of working a metal's surface to improve its material properties, usually by mechanical means or blasts of light beams with laser peening), a heat treatment process (e.g., hardening, tempering, annealing, normalizing, and case hardening), or an aluminizing process (e.g., a high temperature chemical process whereby aluminum vapors diffuse into the surface of the base metal). (Dr. Swanger Declaration - ¶ 58).

Applicant submits that dependent claim 8 is not obvious in view of the teachings of Xiao and Xu for at least the reasons discussed above.

2. Independent Claim 25

Independent claim 25 requires the dissolvable magnesium alloy composite comprise a) at least 85 wt. % magnesium, b) one or more metals selected from the group consisting of 0.5-10 wt. % aluminum, 0.05-6 wt. % zinc, 0.01-3 wt. % zirconium, and 0.15-2 wt. % manganese, c) about 0.05-45 wt. % of a secondary metal to form a galvanically-active intermetallic particle that promotes corrosion of the dissolvable magnesium alloy composite, and d) the secondary metal includes one or more metals selected from the group consisting of copper, nickel, cobalt, titanium, and iron. Applicant submits that these limitations of claim 25 are not anticipated by nor obvious from the teachings of Xiao.

On Pages 13-14 of the NFOA, the Examiner stated that the other than the aluminum limitation, the weight percent ranges of the alloy components of zinc, zirconium, and manganese and the weight percent ranges of the secondary metals overlap the teachings of Xiao. The Examiner concluded that a POSITA would understand that the magnesium alloy composition defined in independent claim 25 would have the same properties as the magnesium alloy taught

by Xiao. The Examiner also stated that Examples 1-7 of Xiao teach greater decomposition rates than required in claim 25.

On Pages 97-98 of the Request, Requester relied on paragraphs 149 and 269 (269 should be paragraph 272) of the Dr. Medlin Declaration to assert that Xiao teaches that the magnesium content of the magnesium alloy can be up to 85 wt.%. Such statements by Requester and Dr. Medlin are misleading with regard to independent claim 25.

Xiao only teaches that the magnesium content can be up to 85 wt.% if the magnesium alloy only includes magnesium, aluminum, and zinc. (Dr. Swanger Declaration - ¶ 55). If the magnesium alloy contains any other metal alloy components, the magnesium content must be less than 85 wt.%. (Dr. Swanger Declaration - ¶55). As such, if the magnesium alloy includes metals other than aluminum and zinc, as required in independent claim 25, then the magnesium content of the magnesium alloy must be less than 85 wt.%. (Dr. Swanger Declaration - ¶55).

Xiao also teaches that when metal additives other than aluminum and zinc are included in the magnesium alloy, not one, but multiple metal additives are included in the magnesium alloy. (Xiao - ¶¶ 12-20, 26, 30-64; Abstract; Table 1; Claim 2). (Dr. Swanger Declaration - ¶ 25). The seven (7) examples of Xiao teach that the magnesium content of the magnesium alloy ranges from 54.5-79.1 wt.%. (Xiao - ¶¶ 33-59; Table 1). (Dr. Swanger Declaration - ¶ 55). As such, Xiao teaches that when metal additives other than aluminum and zinc are included in the magnesium alloy, the magnesium content of the magnesium alloy is significantly less than 85 wt.% so that the required amounts of aluminum and zinc remain in the magnesium alloy. (Dr. Swanger Declaration - ¶ 55).

Applicant submits that Xiao teaches away from a magnesium content of 85 wt.% or more when metal additives other than aluminum and zinc are included in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 25, 55).

Requester, nor the Examiner, asserted that Xiao teaches a secondary metal that forms a galvanically-active intermetallic particle that promotes corrosion. Dr. Medlin in paragraph 280 in Dr. Medlin's Declaration asserted that Xiao teaches the formation of intermetallic particles that include iron, copper, nickel, and silver, and then concluded that such intermetallic particles are galvanically-active intermetallic particles that promotes corrosion.

As discussed above, the teaching of galvanically-active intermetallic particle formation is absent from Xiao. (Dr. Swanger Declaration - ¶¶ 24, 34-54). The corrosion mechanism taught in Xiao is limited to the micro-batteries of MgAl formed in the magnesium alloy due to the high concentration of aluminum (e.g., at least 13 wt.% aluminum) in the magnesium alloy. Xiao teaches that these micro-batteries are the principal driver for decomposition in the magnesium alloy. There is no teaching that iron, copper, nickel and or silver forms micro-batteries in the magnesium alloy. Xiao only teaches that other than aluminum and zinc can, but is not required to, form intermetallic composite micro-particles that promote the decomposition of the magnesium alloy. Xiao does not teach how such intermetallic composite micro-particles, when formed, promote corrosion. As such, the promotion of corrosion by such micro-particles can be by a mechanism other than galvanic action, such as i) promote different grain boundary morphology, ii) induce porosity in the magnesium alloy, iii) increase electrochemical potential difference between phases in the magnesium alloy, etc. (Dr. Swanger Declaration - ¶ 53).

Applicant submits that for at least the reasons set forth above, Xiao does not teach or make obvious the limitations of independent claim 25. Applicant also submits that claims 26-28 which directly depend on independent claim 25 are not anticipated or made obvious by Xiao.

3. Dependent Claim 26

Dependent claim 26 further includes limitations that are not taught or made obvious by Xiao. Dependent claim 26, which depends on independent claim 25, requires a dissolution rate of the magnesium alloy composite to be 100-325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90° C.

On Page 14 of the NFOA, the Examiner stated that the magnesium alloys set forth in Examples 1-7 all fall within 0.005-0.325 g/cm²/hr., thus the limitations of claim 26 are taught by Xiao. Applicant disagrees.

Xiao only teaches a maximum dissolution rate of the magnesium alloy of 0.074 g/cm²/hr. (74 mg/cm²/hr.). (Xiao – Table 2, Example 1). As such, Xiao does not teach or suggest a magnesium alloy that has a dissolution rate that exceeds 0.074 g/cm²/hr. (74 mg/cm²/hr.). (Dr. Swanger Declaration - ¶¶36, 61, 62).

On Pages 100-102 of the Request, Requester also acknowledged that Xiao does not teach a magnesium alloy that has a dissolution rate that exceeds 0.074 g/cm²/hr. (74 mg/cm²/hr.). Requester relies on paragraphs 330-332 of the Dr. Medlin Declaration to assert that a POSITA would understand that the dissolution rates of the magnesium alloy taught in Xiao would be at least 100 g/cm²/hr. (100 mg/cm²/hr.).

As an initial matter, the paragraphs of the Dr. Medlin Declaration cited by Requester are misnumbered since such cited paragraphs of the Dr. Medlin Declaration do not support Requester's assertions in the Request.

Applicant also notes that the Dr. Medlin Declaration is absent a discussion of claim 26. Paragraphs 331-337 of the Dr. Medlin Declaration only discuss Dr. Medlin's opinion that even though Xiao only teaches a dissolution rate of up to 0.074 g/cm²/hr. (74 mg/cm²/hr.), a POSITA would understand dissolution rates of up to 0.085 g/cm²/hr. (85 mg/cm²/hr.) may be possible. There is no discussion by Dr. Medlin that a POSITA would believe, based on the teachings of Xiao, that the magnesium alloy taught by Xiao could have a dissolution rate of up to 0.1 g/cm²/hr. (100 mg/cm²/hr.). Applicant submits that Requester has misrepresented the teachings of Xiao and the opinions of Dr. Medlin when asserting that a POSITA would believe that the magnesium alloy of Xiao could achieve dissolution rates of up to 0.1 g/cm²/hr. (100 mg/cm²/hr.).

Applicant submits that based on the seven (7) examples in Xiao, a POSITA would only believe that the maximum dissolution rate of the magnesium alloy is 0.074 g/cm²/hr. (74 mg/cm²/hr.). (Dr. Swanger Declaration - ¶ 61, 62). Applicant notes that the example in Xiao that includes the largest amounts of metal additive has the lowest dissolution rate. (Xiao – Table 2, Example 2). (Dr. Swanger Declaration - ¶¶46-47). As such, the addition of iron, nickel, copper, and silver to the magnesium alloy appears to affect the dissolution rate, but does not necessarily increase the dissolution rate. (Dr. Swanger Declaration - ¶ 47). Applicant submits that Xiao does not suggest a dissolution rate of the magnesium alloy that is greater than 0.074 g/cm²/hr, and especially not greater than 0.1 g/cm²/hr. (Dr. Swanger Declaration - ¶ 62).

Applicant notes that the decomposition rates taught in Xiao are measured at 93°C, whereas claim 26 defines the decomposition rate at a temperature of 90°C. A POSITA would understand that decomposition rates measured at lower temperatures will have slower decomposition rates. As such, the decomposition rates of the magnesium alloys in Table 2 of Xiao in 3% KCl at 90°C

will have decomposition rates that are less than the decomposition rates listed in Table 2 of Xiao, thus further distinguishing Xiao from the decomposition rate limitations of claim 26.

Dependent claim 26 is also not anticipated or made obvious by the teachings of Xiao for these additional reasons.

4. Dependent Claim 27

Dependent claim 27 further includes limitations that are not taught or made obvious by Xiao. Dependent claim 27, which depends on independent claim 25, requires that the nickel form galvanically-active *in situ* precipitate in the magnesium composite.

On Page 14 of the NFOA, the Examiner did not address the limitation of dependent claim 27 with regard to the nickel forming galvanically-active *in situ* precipitate in the magnesium composite.

On Pages 102-103 of the Request, Requester asserted that Xiao teaches *in situ* precipitation formed of iron, copper, nickel, and/or silver. Requester did not cite to any paragraph of the Dr. Medlin Declaration for support. Applicant notes that the Dr. Medlin Declaration is absent any analysis of claim 27.

As stated above, Xiao does not teach that any particles in the magnesium alloy are formed by *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65). The assertions by Requester that Xiao teaches nickel *in situ* formation are not supported by the teachings of Xiao. Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper,

nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy.

As such, Xiao does not teach the formation of *in situ* precipitate in the magnesium alloy, nor does Xiao teach that nickel forms *in situ* precipitate in the magnesium alloy when added to the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65).

Dependent claim 27 is also not anticipated nor made obvious by the teachings of Xiao for these additional reasons.

5. Independent Claim 33

Independent claim 33 requires the dissolvable magnesium alloy composite comprise 60-95 wt. % magnesium; 0.5-10 wt. % aluminum; 0.05-6 wt. % zinc; 0.15-2 wt. % manganese; and about 0.05-45 wt. % of a secondary metal, and b) the secondary metal includes one or more metals selected from the group consisting of copper, nickel, cobalt, titanium, and iron. Applicant submits that these limitations of claim 33 are not anticipated by nor obvious from the teachings of Xiao.

On Pages 14-15 of the NFOA, the Examiner stated that the magnesium composition taught in Xiao makes obvious the magnesium composite composition defined in independent claim 33. The Examiner also stated that Examples 1-7 of Xiao teach greater decomposition rates than required in claim 33.

On Pages 104-106 of the Request, Requester relied upon the paragraph 149 of Dr. Medlin to assert that Xiao teaches a magnesium content for the magnesium alloy that can range from 60-85 wt.%.

Requester then addressed the aluminum limitation of claim 33 by asserting that a prior art AZ91D magnesium alloy can have an aluminum content of 8.3-9.7, thus a POSITA would

understand that the Xiao magnesium alloy can include an aluminum content of 10 wt.% or less. Requester cites to paragraph 269 of the Dr. Medlin Declaration for support of this assertion.

As an initial matter, paragraphs 149 and 269 are improperly referenced by Requester since these paragraphs either do not pertain to claim 33 or do not support the assertions by Requester. Paragraphs 290-294 of the Dr. Medlin Declaration address the compositional limitations of claim 33. Dr. Medlin asserts that Xiao teaches that aluminum amounts of 8.3-9.7 wt.% can be included in the dissolvable metal alloy based on the composition of AZ91D. However, Dr. Medlin does not address the teaching of Xiao that AZ91D alloy has a very low decomposition rate. Indeed, AZ91D is referenced by Xiao as an unacceptable magnesium alloy. (Xiao - ¶ 3).

Xiao teaches that the aluminum content must be at least 13 wt.% to form the required $M_{17}Al_{12}$ micro-batteries to obtain a decomposition rate of greater than 0.02 g/cm²/hr. at 93°C in 3% KCl. (Xiao - ¶ 26). (Dr. Swanger Declaration - ¶¶ 57, 59, 60, 63, 64). The decomposition rate of AZ91D alloy at 93°C in 3% KCl (0.0005 g/cm²/hr. (0.5 mg/cm²/hr.)) is significantly less than the minimum decomposition rate (5 mg/cm²/hr. 3% KCl at 90°C) defined in claim 33.

Furthermore, based on the Al-Mg phase diagrams, a POSITA would understand that in order to obtain the required MgAl micro-batteries taught by Xiao, the aluminum content in the magnesium alloy needs to be at least 13 wt.%. (Dr. Swanger Declaration - ¶¶ 57, 59, 60, 63, 64).

Applicant submits that, based on the teachings of Xiao, a POSITA would believe that a magnesium alloy must include at least 13 wt.% aluminum to form a magnesium alloy that has the required MgAl micro-batteries to form a magnesium alloy having a high decomposition rate at 93°C in 3% KCl.

On Pages 106-107 of the Request, Requester asserted that Xiao teaches a secondary metal that forms a galvanically-active intermetallic particle that promotes corrosion. Requester relied

on paragraphs 107-108 from Dr. Medlin's Declaration for support for this assertion. Dr. Medlin in paragraphs 296-297 asserted that Xiao teaches the formation of intermetallic particles that include iron, copper, nickel, and silver, and then concluded that such intermetallic particles are galvanically-active intermetallic particles that promote corrosion.

The teaching of galvanically-active intermetallic particle formation is absent from Xiao. (Dr. Swanger Declaration - ¶¶ 34-54). The corrosion mechanism taught in Xiao is limited to the micro-batteries of MgAl formed in the magnesium alloy due to the high concentration of aluminum (e.g., at least 13 wt.% aluminum) in the magnesium alloy. Xiao teaches that these micro-batteries are the principal driver for decomposition in the magnesium alloy. There is no teaching that iron, copper, nickel, and/or silver forms micro-batteries in the magnesium alloy. Xiao only teaches that iron, copper, nickel, and/or silver can, but is not required to, form intermetallic composite micro-particles that promote the decomposition of the magnesium alloy. Xiao does not teach how such intermetallic composite micro-particles, when formed, promote corrosion. As such, the promotion of corrosion by such micro-particles can be by a mechanism other than galvanic action, such as i) promote different grain boundary morphology, ii) induce porosity in the magnesium alloy, iii) increase electrochemical potential difference between phases in the magnesium alloy, etc. (Dr. Swanger Declaration - ¶ 53).

Applicant submits that, for at least the reasons set forth above, Xiao does not teach or make obvious the limitations of independent claim 33. Applicant also submits that claims 34-36 which directly depend on independent claim 33 are not anticipated or made obvious by Xiao.

6. Dependent Claim 35

Dependent claim 35 further includes limitations that are not taught or made obvious by Xiao. Dependent claim 35, which depends on independent claim 33, requires that the nickel form galvanically-active *in situ* precipitate in the magnesium composite.

On Page 15 of the NFOA, the Examiner did not address the limitation of dependent claim 35 with regard to the nickel forming galvanically-active *in situ* precipitate in the magnesium composite.

On Pages 110-111 of the Request, Requester asserted that Xiao teaches *in situ* precipitation formed of iron, copper, nickel, and/or silver. Requester relied on paragraphs 107 and 108 of the Dr. Medlin Declaration to assert that Xiao would teach a POSITA that *in situ* precipitation formed of nickel forms galvanically-active intermetallic phases or micro-batteries in the magnesium composite. Applicant notes that the Dr. Medlin Declaration is absent any discussion regarding the patentability of claim 35.

As stated above, Xiao does not teach that any particles in the magnesium alloy are formed by *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65). The assertions by Requester that Xiao teaches nickel *in situ* formation are not supported by the teachings of Xiao. Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy.

As such, Xiao does not teach the formation of *in situ* precipitate in the magnesium alloy, nor does Xiao teach that nickel forms *in situ* precipitate in the magnesium alloy when added to the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 24, 34-54, 65).

Dependent claim 35 is also not anticipated nor made obvious by the teachings of Xiao for these additional reasons.

7. Dependent Claim 55

Dependent claim 55 further includes limitations that are not taught or made obvious by Xiao. Dependent claim 55, which depends on independent claim 49, requires the magnesium composite include at least 85 wt.% magnesium, and one or more metals selected from the group consisting of 0.5-10 wt.% aluminum, 0.05-6 wt.% zinc, 0.01-3 wt.% zirconium, and 0.15-2 wt.% manganese. Since claim 55 depends on claim 49, claim 55 also requires the magnesium alloy include 0.05-45 wt.% of an additive material, which additive material includes one or more metals selected from the group consisting of copper, nickel, titanium, iron, and cobalt.

On page 16 of the NFOA, the Examiner stated that most of the metal components defined in claim 55 overlap the metal component ranges taught in Xiao, thus the limitations of claim 55 would be obvious in view of Xiao. The Examiner did not specifically address the 85 wt.% magnesium limitation in claim 55.

On Pages 111-114 of the Request, Requester relied on paragraphs 149 and 269 of Dr. Medlin to assert that Xiao teaches that the magnesium content of the magnesium alloy can be up to 85 wt.%.

As discussed above with regard to independent claim 25, the statements by Requester and Dr. Medlin regarding the 85 wt.% upper limit for magnesium in the Xiao magnesium alloy are misleading. Xiao only teaches that the magnesium content can be up to 85 wt.% if the magnesium

alloy only includes magnesium, aluminum, and zinc. (Dr. Swanger Declaration - ¶55). If the magnesium alloy contains any other metal alloy components, the magnesium content must be less than 85 wt.%. (Dr. Swanger Declaration - ¶ 55). As such, if the magnesium alloy includes metals other than aluminum and zinc, as required in dependent claim 55, then the magnesium content of the magnesium alloy must be less than 85 wt.%. (Dr. Swanger Declaration - ¶¶ 25, 55).

As discussed above, Xiao also teaches that when metal additives other than aluminum and zinc are included in the magnesium alloy, not one, but multiple metal additives are included in the magnesium alloy. (Xiao - ¶¶12-20, 26, 30-64; Abstract; Table 1; Claim 2). (Dr. Swanger Declaration - ¶¶ 25, 55). Based on the broadest teaching of Xiao as set forth in claim 2 and paragraphs 13-20, when the magnesium alloy includes metal additive other than aluminum and zinc, the magnesium alloy includes 13-25 wt.% aluminum, 2-15 wt.% zinc, 0.1-5 wt.% iron, 0.05-5 wt.% copper, 0.05-5 wt.% nickel, 0-5 wt.% silver, 0.05-0.5 wt.% zirconium, 0.05-0.5 wt.% titanium and the balance magnesium. The seven (7) examples of Xiao teach that the magnesium content of the magnesium alloy ranges from 54.5-79.1 wt.%. (Xiao - ¶¶ 33-59; Table 1). (Dr. Swanger Declaration - ¶ 55). As such, Xiao teaches that when metal additives other than aluminum and zinc are included in the magnesium alloy, the magnesium content of the magnesium alloy is significantly less than 85 wt.% so that the required amounts of aluminum and zinc remain in the magnesium alloy. (Dr. Swanger Declaration - ¶ 55).

Applicant submits that Xiao teaches away from a magnesium content of 85 wt.% or more when metal additives other than aluminum and zinc are included in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 25, 55).

Applicant submits that for at least the reasons set forth above, Xiao does not teach or make obvious the limitations of dependent claim 55.

8. Dependent Claim 58

Dependent claim 58 further includes limitations that are not taught or made obvious by Xiao. Dependent claim 58, which depends on independent claim 49, requires the magnesium composite comprise 60-95 wt. % magnesium, 0.5-10 wt. % aluminum, 0.05-6 wt. % zinc, and 0.15-2 wt. % manganese. Since dependent claim 58 depends on claim 49, claim 58 also requires the magnesium alloy include 0.05-45 wt.% of an additive material, which additive material includes one or more metals selected from the group consisting of copper, nickel, titanium, iron and cobalt.

On Pages 16-17 of the NFOA, the Examiner stated that the magnesium composition taught in Xiao makes obvious the magnesium composite composition defined in claim 58.

Applicant notes that Requester did not assert that claim 58 was unpatentable in view of Xiao and/or Hassan. Applicant also notes that the Dr. Medlin Declaration is absent any analysis of claim 58. As such, it appears that the Examiner made an independent determination that the limitations of claim 58 are obvious in view of Xiao.

Dependent claim 58 requires the magnesium composite have an aluminum content of 0.5-10 wt.%. The Examiner reference the AZ91D alloy in Xiao as teaching that a magnesium alloy can include an aluminum content as low as 8.3-9.7 wt.%. However, the Examiner does not address the teaching of Xiao that AZ91D alloy has a very low decomposition rate. Indeed, AZ91D is referenced by Xiao as an unacceptable magnesium alloy. (Xiao - ¶3).

Xiao teaches that the aluminum content must be at least 13 wt.% to form the required $M_{17}Al_{12}$ micro-batteries to obtain a decomposition rate of greater than 0.02 g/cm/hr. at 93°C in 3% KCl. (Xiao - ¶ 26). (Dr. Swanger Declaration - ¶¶ 57, 59, 60, 63, 64). The decomposition rate of

AZ91D alloy at 93°C in 3% KCl (0.0005 g/cm²/hr. (0.5 mg/cm²/hr.) is significantly less than the minimum decomposition rate (5 mg/cm²/hr. 3% KCl at 90°C) defined in claim 58.

As discussed above with regard to claim 33, a POSITA upon reviewing the Al-Mg phase diagrams would understand that in order to obtain the require MgAl micro-batteries taught by Xiao, the aluminum content in the magnesium alloy needed to be at least 13 wt.%. (Dr. Swanger Declaration - ¶¶ 57, 59, 60, 63, 64).

Applicant submits that, based on the teachings of Xiao, a POSITA would believe that a magnesium alloy must include at least 13 wt.% aluminum to form a magnesium alloy that has a high decomposition rate at 93°C in 3% KCl. As such, the limitations of dependent claim 58 with regard to the aluminum limitation teaches away from the high aluminum requirement of Xiao that is required to form the micro-batteries in the magnesium alloy.

Applicant submits that for at least the reasons set forth above, Xiao does not teach or make obvious the limitations of dependent claim 58.

8. Independent Claim 74

Independent claim 74 requires the dissolvable magnesium composite include a) *in situ* precipitation of galvanically-active intermetallic phases to enable controlled dissolution of said magnesium composite, b) the magnesium composite comprises a mixture of magnesium or a magnesium alloy and an additive material, c) the additive material constitutes at least 0.1 wt. % of said mixture, d) the magnesium in the magnesium composite constituting at least 85 wt.%, e) the additive material is a metal material selected from the group consisting of copper, nickel and cobalt, f) the magnesium composite includes *in situ* precipitation of galvanically-active intermetallic phases that include the additive material, and g) the magnesium composite has a

dissolution rate of 84-325 mg/cm²/hr. in 3 wt. % KCl water mixture at 90°C. Applicant submits that these limitations of claim 74 are not anticipated by nor obvious from the teachings of Xiao.

On Page 17 of the NFOA, the Examiner asserted that Xiao teaches a magnesium alloy that has a magnesium content of slightly less than 85 wt.% magnesium when the magnesium alloy includes additive, thus the 85 wt.% magnesium limitation of claim 74 would be obvious to a POSITA from the teachings of Xiao. The Examiner stated that most of the metal components defined in claim 74 are close to or overlap the metal component ranges taught in Xiao, thus the metal addition limitations of claim 74 would be obvious in view of Xiao. The Examiner also asserted that the decomposition rate of 84-325 mg/cm²/hr. in 3 wt.% KCl water mixture at 90°C of claim 74 is close to the decomposition rate of 74 mg/cm²/hr. in 3 wt.% KCl water mixture at 93°C of Example 1 of Xiao, thus the decomposition rate defined in claim 74 would be obvious to a POSITA based on the teachings of Xiao. The Examiner did not address the *in situ* limitations of claim 74.

On Pages 114-115 and 118-119 of the Request, Requester relied on paragraphs 107, 108 and 256 of the Dr. Medlin Declaration to assert Xiao teaches *in situ* precipitation that includes metal additive.

As stated above with regard to independent claims 1, 49 and 73, Xiao does not teach a magnesium alloy that includes *in situ* precipitate. Xiao only teaches “Elements such as Fe, Cu, Ni, Ag, etc., in the magnesium alloy *can form* a large number of intermetallic composite micro-particles, which *can improve* the corrosion performance of the magnesium alloy, thereby promoting the decomposition of the magnesium alloy.” (emphasis added) (Xiao - ¶26). There is no direct or inherent teaching in Xiao that iron, copper, nickel, or silver, when added to the

magnesium alloy, form *in situ* precipitate in the magnesium alloy. (Dr. Swanger Declaration - ¶¶34-54).

The conclusory assertion by Dr. Medlin that a POSITA would understand that intermetallic particles formed by *in situ* precipitation from the addition of iron, copper, nickel, and silver is not supported by the teachings of Xiao. However, as discussed above with regard to claims 1, 49 and 73, Xiao does not teach the mechanism in which *in situ* intermetallic particles of iron, copper, nickel, and silver are formed in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 34-54).

As discussed by Dr. Swanger, there is no teaching in Xiao that I) *in situ* precipitate is formed in the magnesium composite, and II) *in situ* precipitate that includes copper, nickel, titanium, iron, and/or cobalt is formed in the magnesium composite. (Dr. Swanger Declaration - ¶¶ 34-54).

Requester on Pages 116-188 relied on paragraphs 149 and 269 of Dr. Medlin to assert that Xiao teaches the magnesium content of the magnesium alloy can be up to 85 wt.%. Similar to the discussion above with regard to independent claim 25 and dependent claim 55, such statements by Requester and Dr. Medlin are misleading with regard to maximum content of magnesium in the magnesium alloy. Xiao only teaches that the magnesium content can be up to 85 wt.% if the magnesium alloy only includes magnesium, aluminum, and zinc. (Dr. Swanger Declaration - ¶¶ 25, 55). If the magnesium alloy includes any other metal alloy components, the magnesium content must be less than 85 wt.%. (Dr. Swanger Declaration - ¶¶ 25, 55). As such, if the magnesium alloy includes metals other than aluminum and zinc, as required in independent claim 74, then the magnesium content of the magnesium alloy must be less than 85 wt.%. (Dr. Swanger Declaration - ¶¶ 25, 55).

As discussed above, Xiao teaches that for a magnesium alloy to have a decomposition rate of greater than 0.02 g/cm/hr. at 93°C in 3% KCl, the magnesium alloy must include at least 13 wt.% aluminum to form the required quantity of $M_{17}Al_{12}$ micro-batteries in the magnesium alloy. (Xiao - ¶¶ 3, 4, 6-11, 25-27-65; Tables 1-2). (See also Dr. Swanger Declaration - ¶¶ 56, 57, 59, 60, 63, 64). Xiao does not teach or suggest a magnesium content that is or exceeds 85 wt.% when metal additives other than aluminum and zinc are included in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 25, 55).

Xiao teaches that when metal additives are included in the magnesium alloy other than aluminum and zinc, not one, but multiple metal additives are included in the magnesium alloy. (Xiao - ¶¶ 12-20, 26, 30-64; Abstract; Table 1; Claim 2). (Dr. Swanger Declaration - ¶¶ 25, 55). Based on the broadest teaching of Xiao as set forth in claim 2 and paragraphs 13-20, when the magnesium alloy includes metal additive other than aluminum and zinc, the magnesium alloy includes 13-25 wt.% aluminum, 2-15 wt.% zinc, 0.1-5 wt.% iron, 0.05-5 wt.% copper, 0.05-5 wt.% nickel, 0-5 wt.% silver, 0.05-0.5 wt.% zirconium, 0.05-0.5 wt.% titanium, and the balance magnesium. The seven (7) examples of Xiao teach that the magnesium content of the magnesium alloy ranges from 54.5-79.1 wt.%. (Xiao - ¶¶ 33-59; Table1). (Dr. Swanger Declaration - ¶ 55). As such, Xiao teaches that when metal additives other than aluminum and zinc are included in the magnesium alloy, the magnesium content of the magnesium alloy is less than 85 wt.% so that the required amounts of aluminum and zinc remain in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 25, 55).

Applicant submits that Xiao teaches away from a magnesium content of 85 wt.% or more when metal additives other than aluminum and zinc are included in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 25, 55).

On Page 17 of the NFOA, the Examiner stated that the decomposition rate of magnesium alloy of Example 1 is of 0.074 g/cm²/hr. at 93°C in 3 wt.% KCl (74 mg/cm²/hr.) is close to the lower decomposition rate of 84 mg/cm²/hr. at 90°C in 3 wt.% KCl; thus, a POSITA would understand that the magnesium alloy taught by Xiao could be modified to obtain a decomposition rate of 84 mg/cm²/hr. at 90°C in 3 wt.% KCl. On Pages 119-122 of the Request, Requester relied up on paragraphs 129, 130, 132, 149, 269, 330, and 332 of Dr. Medlin to assert that the 84 mg/cm²/hr. at 90°C in 3 wt.% KCl limitation of claim 74 is disclosed by Xiao. Applicant notes that paragraphs 129, 130, 132, 149, 269, 330, and 332 of Dr. Medlin do not address the 84 mg/cm²/hr. at 90°C in 3 wt.% KCl limitation of claim 74. However, paragraph 335 of the Dr. Medlin Declaration concluded that a POSITA would believe, based on the teachings of Xiao, that dissolution rates of greater than 0.074 g/cm²/hr. at 93°C in 3 wt.% KCl (74 mg/cm²/hr.) may achievable based on the teachings of Xiao. Dr. Medlin states that higher concentrations of copper, nickel, and/or iron in the magnesium alloy could achieve higher dissolution rates. However, the examples of Xiao teach otherwise.

Based on the examples of Xiao, an increase in the amount of additives to the magnesium alloy results in a decrease in dissolution rate. (Dr. Swanger Declaration - ¶¶ 46, 47, 61). Examples 3-5 illustrate magnesium compositions that include a maximum content of copper, nickel, and/or iron; however, these dissolution rates do not exceed 74 mg/cm²/hr. at 93°C in 3 wt.% KCl. There is no suggestion in Xiao that dissolution rates that exceed 74 mg/cm²/hr. at 93°C in 3 wt.% KCl can be obtained. (Dr. Swanger Declaration - ¶ 61).

Applicant submits that based on the seven (7) examples in Xiao, a POSITA would only believe that the maximum dissolution rate of the magnesium alloy is 0.074 g/cm²/hr. (74 mg/cm²/hr.). (Dr. Swanger Declaration - ¶¶ 46, 47, 61).

Applicant also notes that the decomposition rates taught in Xiao are measured at 93°C, whereas claim 74 defines the decomposition rate at a temperature of 90°C. A POSITA would understand that decomposition rates measured at lower temperatures will have slower decomposition rates. As such, the decomposition rates of the magnesium alloys in Table 2 of Xiao in 3% KCl at 90°C will have decomposition rates that are less than the decomposition rates listed in Table 2 of Xiao, thus further distinguishing Xiao from the decomposition rate limitations of claim 74.

The Examiner did not comment on the *in situ* limitation of claim 74. On Pages 114-115 and 118-119, Requester relied on paragraphs 107, 108 and 256 of the Dr. Medlin Declaration to assert that Xiao teaches a magnesium alloy that includes *in situ* precipitate and that such *in situ* precipitate includes copper or nickel. In paragraphs 315-317 and 328-330 of the Dr. Medlin Declaration, Dr. Medlin also concluded that Xiao teaches a magnesium alloy that includes *in situ* precipitate and that such *in situ* precipitate includes copper or nickel.

As discussed above with regard to independent claim 1 and 49, Xiao does not teach a magnesium alloy that includes *in situ* precipitate of galvanically-active intermetallic phases to enable controlled dissolution of the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 34-54).

Xiao only teaches “Elements such as Fe, Cu, Ni, Ag, etc., in the magnesium alloy *can form* a large number of intermetallic composite micro-particles, which *can improve* the corrosion performance of the magnesium alloy, thereby promoting the decomposition of the magnesium alloy.” (emphasis added) (Xiao - ¶ 26). There is no other teaching in Xiao regarding particles, micro-particles, or intermetallic particles.

Xiao does not teach the formation of these possible intermetallic composite micro-particles by an *in situ* process. (Dr. Swanger Declaration - ¶¶ 24, 34, 37, 38, 41, 44, 45, 49-54). Xiao merely

discloses a eutectic (formed during solidification) phase on the grain boundary, which is not a galvanically-active *in situ* precipitate as recited in the claims of the '795 Reexam. (Dr. Swanger Declaration - ¶¶ 30, 36, 37, 59, 60). In requiring the eutectically-formed Mg-Al – Mg micro-batteries, Xiao *teaches away* from the claims of the '795 Reexam which requires galvanically-active *in situ* precipitates formed between the magnesium alloy and the additive material, newly formed galvanically-active intermetallic particles, or un-melted remnants of elemental secondary metal additives. (Dr. Swanger Declaration - ¶¶ 37, 54). There is no direct or inherent teaching in Xiao that iron, copper, nickel, and silver, when added to the magnesium alloy, form *in situ* precipitate in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 34-54).

As discussed above, the Mg-Al micro-batteries taught by Xiao are not disclosed as formed by *in situ* precipitate. The aluminum in the beta phase is not *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 37, 38, 49-51, 53, 54). Precipitate is first mentioned in Xiao with regard to the optional addition of iron, copper, nickel, silver, zirconium, and titanium to the magnesium alloy. There is no teaching in Xiao that the MgAl micro-batteries form precipitate in the magnesium alloy, nor that the MgAl micro-batteries form *in situ* precipitate in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 37, 38, 49-51, 53, 54). Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy. Xiao does not teach a magnesium alloy that includes *in situ* precipitation, nor that any

precipitate of iron, copper, nickel, and silver is *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 34-54).

Applicant submits that for at least the reasons set forth above, Xiao does not teach or make obvious the limitations of independent claim 74. Applicant also submits that claims 75-76 which directly depend on independent claim 74 are not anticipated or made obvious by Xiao.

B. Patentability of Claims in View of Xiao and Hassan

On Pages 17-21 of the NFOA, the Examiner asserted that claims 7, 12-16, 18-21, 23, 24 and 71 of the ‘795 Reexam were rejected under U.S.C. 103(a) as being unpatentable over Xiao in view of Hassan.

1. Hassan

Hassan teaches that one motivation to develop new magnesium alloys was that magnesium alloys are increasingly subject to hostile service conditions and new alloys with enhanced properties need to be developed to withstand such hostile conditions. (Hassan – Section 1). A POSITA would understand that a corrosive environment is considered a “hostile” environment to metals and metal alloys. As such, a POSITA would be led to believe that the MgNi alloys tested in Hassan would stand up well to “hostile” environments, including corrosive environments.

Hassan identified two strong additive candidates to be mixed with magnesium to improve the mechanical properties of the magnesium alloy, namely nickel and SiC. (Hassan – Section 1). Hassan stated that SiC additions to magnesium have been long studied and such SiC additions to magnesium have resulted in limited success in improving the overall mechanical properties of the magnesium alloy. (Hassan – Section 1).

The magnesium alloy that was the subject of analysis was limited to a binary magnesium alloy only formed of magnesium and nickel. (Hassan - Sections 1, 2.1-2.2; Tables 1-4). No other metal additives to the magnesium alloy are discussed in Hassan. Three binary MgNi alloys were tested, namely Mg/7.3 Ni, Mg/14.0Ni, and Mg/24.9Ni. (Hassan - Sections 2.3; Tables 1-4). Applicant notes that the minimum nickel content of the three binary magnesium alloys tested in Hassan is significantly greater than the maximum allowable nickel content (5 wt.%) of the magnesium alloy taught in Xiao. (Xiao – ¶¶ 17, 33-60; Table 1; Claim 2).

The three binary MgNi alloys were formed by superheating the magnesium and then adding and mixing nickel particles to the superheated magnesium to form a uniform distribution of nickel in the MgNi alloy. (Hassan – Section 2.2). The molten mixture was then cooled to form 40 mm diameter ingots of the binary MgNi alloy. (Hassan – Section 2.2). Thereafter, the ingots were machined to a 36 mm diameter and then hot extruded to form 8 mm rods of the binary MgNi alloy. (Hassan – Section 2.2).

The quantitative assessment of the three binary MgNi alloys revealed the presence of nickel particulates distributed uniformly in the magnesium matrix of the three binary MgNi alloys. (Hassan – Sections 3.2, 4.2).

Hassan does not provide any corrosion data for the three binary MgNi alloys. In view of the basis for developing the three binary MgNi alloys as discussed in Hassan, namely forming a magnesium alloy that can withstand the increased hostile service conditions to which magnesium alloys are subjected (Hassan – Section 1), a POSTIA would have concluded that the three binary MgNi alloys were formulated to withstand such “hostile” conditions, which would naturally include a hostile corrosive environment. (Dr. Swanger Declaration - ¶¶ 32, 33, 76, 77).

2. Dependent Claim 7

Dependent claim 7 further includes limitations that are not taught or made obvious by the combined teachings of Xiao and Hassan. Dependent claim 7, which depends on independent claim 1, requires the magnesium composite to be subjected to a deformation processing to reduce grain size of the magnesium composite, increase tensile yield strength of the magnesium composite, increase elongation of the magnesium composite, or combinations thereof.

On Page 18 of the NFOA, the Examiner acknowledged that Xiao does not teach the limitations of claim 7. The Examiner asserted that Hassan teaches the hot extrusion of nickel-reinforced magnesium which modifies the microstructure of the Mg-Ni intermetallics, thus makes obvious the limitations of claim 7.

On Page 127 of the Request, Requester concluded that Hassan explicitly discloses a deformation process which results in the reduction of the size of the elemental nickel particulates in the extruded MgNi composite. In paragraphs 344-350 of the Dr. Medlin Declaration, Dr. Medlin stated that a POSITA would be motivated to further modify the magnesium alloy taught by Xiao to further increase and/or control the rate of dissolution, and that a POSITA would look to the teachings of Hassan to obtain such increased and/or controlled the rate of dissolution.

As discussed above, Hassan teaches a binary MgNi alloy that has improved properties to hostile environments as compared to an AZ91-silicon carbide alloy. (Hassan – Abstract; Section 1). (Dr. Swanger Declaration - ¶¶ 32, 33, 68). The three binary MgNi alloys taught in Hassan include 7.3Ni, 14.0Ni, and 24.9Ni. (Hassan - Sections 2.3; Tables 1-4). All three of these tested binary MgNi alloys have a nickel content that exceeds the maximum and allowable nickel content taught by Xiao. (Xiao – ¶¶ 17, 26, 33-63; Table 1; Claim 2). As such, the binary MgNi taught by

Hassan teach away from the magnesium alloy taught by Xiao. (Dr. Swanger Declaration - ¶¶ 33, 74, 75, 77).

Hassan is also absent teachings regarding the decomposition properties of the tested binary MgNi alloys. (Dr. Swanger Declaration - ¶76). Based on the teachings of Hassan, the tested binary MgNi alloys were formulated to improve the properties of the alloys in hostile environments as compared to a prior art AZ91-silicon carbide alloy. A POSITA would understand from Hassan that the binary MgNi alloys have superior properties in hostile environments such as a corrosive environment. (Dr. Swanger Declaration - ¶¶ 32, 73, 76, 77). As such, a POSITA would not look to the teachings of Hassan regarding the formation of fast decomposing magnesium alloys, nor be motivated by any teachings in Hassan to modify the magnesium alloy taught by Xiao. (Dr. Swanger Declaration - ¶¶ 32, 67, 68, 72, 73, 75-77).

The Examiner relied upon Hassan regarding the secondary processing of the binary MgNi alloy of hot extrusion to assert that Hassan would motivate a POSITA to similarly process the magnesium alloy of Xiao. However, Hassan is absent any comparative analysis of the properties of a non-extruded and extruded binary MgNi alloy. Hassan is absent teachings that the hot extrusion of the binary MgNi alloy improves the properties of such alloy. (Dr. Swanger Declaration - ¶ 79). All of the properties of the binary MgNi alloys tested in Hassan are attributed to the nickel content of the MgNi alloy, not to the secondary hot extrusion of the MgNi alloys. (Dr. Swanger Declaration - ¶ 79). Furthermore, Hassan does not teach that the hot extrusion of the MgNi alloy has any effect on the grain size of MgNi alloy. (Dr. Swanger Declaration - ¶¶ 71, 79).

As such, there is no teaching in Hassan that hot extrusion of binary MgNi alloys improves or changes the properties of binary MgNi alloys as compared to non-extruded binary MgNi alloys. (Dr. Swanger Declaration - ¶¶ 71, 79).

The Requester, Dr. Medlin, and the Examiner did not address the fact that the magnesium alloy of Hassan is a binary MgNi alloy that includes a nickel content significantly greater than the maximum nickel content taught by Xiao. The binary MgNi alloy of Hassan is not the high aluminum content magnesium alloy taught by Xiao. Xiao teaches that the decomposable magnesium alloy must be at least a tertiary alloy of MgNiZn having an aluminum content of at least 13 wt.%. Xiao teaches that nickel is only an optional additive to the MgNiZn alloy. (Xiao – ¶ 26; Claims 1-2). A POSITA would understand that the chemistry, mechanical properties, crystalline structure, precipitate composition, and precipitate distribution of the binary MgNi alloy taught by Hassan and the multicomponent high aluminum content magnesium composite taught by Xiao will be different. (Dr. Swanger Declaration - ¶¶ 73-74). As such, there is no teachings in Xiao or Hassan that would motivate a POSITA to modify the magnesium alloy taught by Xiao in view of the teachings of Hassan. (Dr. Swanger Declaration - ¶¶ 32, 33, 67, 68, 73-77).

Applicant submits that for at least the reasons set forth above, the combined teachings of Xiao and Hassan do not make obvious the limitations of dependent claim 7.

3. Independent Claim 12

Independent claim 12 requires a magnesium composite that a) includes *in situ* precipitation of galvanically-active intermetallic phases to enable controlled dissolution of the magnesium composite, b) the additive material includes one or more metals selected from the group consisting of copper, nickel, cobalt, titanium, and iron, c) at least a portion of the additive material remaining unalloyed additive material, d) the magnesium composite includes *in situ* precipitation of galvanically-active intermetallic phases that includes the unalloyed additive material, e) the additive material has a greater melting point temperature than a solidus temperature of the magnesium, and f) the additive material has a melting point temperature that is 100°C greater than

a melting temperature of the magnesium or magnesium alloy. Applicant submits that these limitations of claim 12 are not anticipated by nor obvious from the combined teachings of Xiao and Hassan.

On Pages 18-19 of the NFOA, the Examiner asserted that Xiao teaches all of the limitations of claim 12 except for the limitation that at least a portion of the additive material remains unalloyed additive material. The Examiner relied upon Hassan for teachings that some of the nickel in the binary MgNi alloy remains unalloyed in the MgNi alloy. The Examiner concluded that, based on such teaching of Hassan, it would be obvious to a POSITA that some of the additive material defined in claim 12 would remain unalloyed in the magnesium composite.

On Pages 128-137 of the Request, Requester likewise asserted that Xiao teaches all of the limitations of claim 12 except for the limitation that at least a portion of the additive material remains unalloyed additive material. Requester, similar to the Examiner, relied upon the teachings of Hassan to teach such limitation, and on the Dr. Medlin Declaration to assert that a POSITA would be motivated to combine the teachings of Hassan with Xiao.

The Examiner did not address the *in situ* limitations of claim 12. On Pages 128-129 and 135-136 of the Request, Requester asserted that Xiao teaches *in situ* precipitation that includes metal additive. Applicant notes that Dr. Medlin at paragraphs 354-355 and 390-392 also concluded that Xiao teaches *in situ* precipitate is formed in the magnesium alloy of Xiao and that based on the teachings of Hassan, a POSITA would understand that some of the *in situ* precipitate includes unalloyed amounts of additive material.

As stated above with regard to independent claims 1, 49, 73 and 74, Xiao does not teach a magnesium alloy that includes *in situ* precipitate of galvanically-active intermetallic phases to enable controlled dissolution of the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 34-54).

Xiao only teaches “Elements such as Fe, Cu, Ni, Ag, etc., in the magnesium alloy *can form* a large number of intermetallic composite micro-particles, which *can improve* the corrosion performance of the magnesium alloy, thereby promoting the decomposition of the magnesium alloy.” (emphasis added) (Xiao - ¶26). There is no other teaching in Xiao regarding particles, micro-particles or intermetallic particles.

Xiao does not teach the formation of these possible intermetallic composite micro-particles by an *in situ* process. (Dr. Swanger Declaration - ¶¶ 24, 34, 37, 38, 41, 44, 45 49-54). Xiao merely discloses a eutectic (formed during solidification) phase on the grain boundary, which is not a galvanically-active *in situ* precipitate as recited in the claims of the ‘795 Reexam. (Dr. Swanger Declaration - ¶¶ 30, 36, 37, 59, 60). In requiring the eutectically-formed Mg-Al – Mg micro-batteries, Xiao *teaches away* from the claims of the ‘795 Reexam which require galvanically-active *in situ* precipitates formed between the magnesium alloy and the additive material, newly formed galvanically-active intermetallic particles, or un-melted remnants of elemental secondary metal additives. (Dr. Swanger Declaration - ¶¶ 37, 54). There is no direct or inherent teaching in Xiao that iron, copper, nickel, and silver, when added to the magnesium alloy, form *in situ* precipitate in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 34-54).

As discussed above, the Mg-Al micro-batteries taught by Xiao are not disclosed as formed by *in situ* precipitate. The aluminum in the beta phase is not *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 37, 38, 49-51, 53, 54). Precipitate is first mentioned in Xiao with regard to the optional addition of iron, copper, nickel, silver, zirconium, and titanium to the magnesium alloy. There is no teaching in Xiao that the MgNi micro-batteries form precipitate in the magnesium alloy, nor that the MgNi micro-batteries form *in situ* precipitate in the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 37, 38, 49-51, 53, 54). Xiao only teaches that magnesium and aluminum

combine to form the micro-batteries in the magnesium alloy. There is no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy. Xiao does not teach a magnesium alloy that includes *in situ* precipitation, nor that any precipitate of iron, copper, nickel, and silver is *in situ* precipitate. (Dr. Swanger Declaration - ¶¶ 34-54).

The Examiner, Requester, and Dr. Medlin asserted that Hassan teaches unalloyed nickel in the binary MgNi alloy, thus such teaching in Hassan would teach a POSITA that nickel additions to the magnesium alloy taught by Xiao would remain unalloyed in the magnesium alloy and form *in situ* precipitate in the magnesium alloy.

As discussed above, Hassan teaches a MgNi binary alloy that includes at least 7.3 wt.% nickel. Xiao teaches a tertiary magnesium alloy that includes magnesium, aluminum, and zinc. Xiao also teaches that the maximum content of nickel can be 5 wt.%, which is significantly less than the minimum nickel content of the MgNi alloy taught by Hassan. A POSITA would understand that the formation of alloys and particulate by nickel in a high nickel content binary MgNi alloy will be different in a high aluminum content tertiary MgNiZn alloy that includes significantly less nickel than disclosed in the MgNi alloy of Hassan. (Dr. Swanger Declaration - ¶¶ 73, 74, 75). Applicant submits that Dr. Medlin, Requester, and the Examiner have merely speculated that unalloyed nickel precipitate or any other secondary unalloyed precipitate will form in the magnesium alloy of Xiao. As discussed above, there is no teaching in Xiao to teach or

suggest that any type of *in situ* precipitate will be formed in the magnesium alloy of Xiao. (Dr. Swanger Declaration - ¶¶ 34-54).

Applicant that contrary to the assertions of the Examiner, Requester and Dr. Medlin, Xiao teaches that all of the components of the alloy are first melted together prior to forming the solid alloy. (Xiao - ¶ 22). Xiao also only teaches that if precipitate is formed in the magnesium alloy, such precipitate is a composite micro-particle, not an elemental particle. (Xiao - ¶ 22). Such teaching in Xiao directly contradicts the assertion that unalloyed Ni exists in the magnesium alloy taught by Xiao.

Furthermore, Hassan teaches a process to attempt to keep as much nickel in elemental particle form as possible in the final MgNi alloy. (Dr. Swanger Declaration - ¶ 74). As such, Xiao teaches away from the limitation of claim 12 that unalloyed *in situ* precipitate of iron, copper, nickel, and/or silver will form in the magnesium alloy of Xiao. (Dr. Swanger Declaration - ¶ 80).

Applicant further submits that the very different binary MgNi alloy taught by Hassan also does not teach or suggest to a POSTIA that unalloyed *in situ* precipitate of iron, copper, nickel, and/or silver will form in the magnesium alloy of Xiao. (Dr. Swanger Declaration - ¶ 80).

On Page 18 of the NFOA, the Examiner stated that the since the melting point temperature of the claimed alloy are available, a POSITA would have expected to use intermediate alloys having a melting point temperature of 100°C greater than the magnesium or magnesium alloy.

On Page 129-134 of the Request, Requester also asserted that a POSTIA would understand that the additive material has a greater melting point temperature than a solidus temperature of the magnesium, and the additive material has a melting point temperature that is 100°C greater than a melting temperature of the magnesium or magnesium alloy. Dr. Medlin in paragraphs 360-373 and 377-382 of the Dr. Medlin Declaration relied upon phase diagrams to also assert that a

POSITA would have expected to use intermediate alloys having a melting point temperature of 100°C greater than the magnesium or magnesium alloy.

As discussed above with regard to claim 1, the assertions by the Examiner, Requester, and Medlin do not account for the teaching in Xiao that the additives are added to the magnesium and aluminum melt at a temperature of 700-730°C, and then the temperature is raised to 740-780°C to cause all of the additive to melt in the mixture, and then the temperature was lowered to 700-720°C for some time period prior to the casting of the magnesium alloy. (Xiao - ¶ 22). As taught in Claim 2 and the Examples 1-7 of Xiao, the additives of iron, copper, nickel, silver, titanium, and zirconium are added to the mixture and are required to be fully melted in the magnesium molten mixture. A POSITA would understand from the teachings of Xiao that these additives cannot be added in pure form, but must be added as an intermediate alloy. (Xiao - ¶¶ 23, 36, 40, 44, 48, 52, 56, 60).

In order to ensure that the additives fully melt in the magnesium mixture, a POSITA would select certain aluminum-additive mixtures that have a lower melting point. (Dr. Swanger Declaration - ¶¶ 42, 43). A POSITA would understand that such additives will have a melting point that is substantially less than 700°C. (Xiao - ¶¶ 22-23; Dr. Swanger Declaration - ¶¶ 42, 43). Xiao teaches that the additives are not added in pure form, but as an alloy of aluminum. There is no teaching or suggestion in Xiao that a POSITA would be motivated to select an alloy of aluminum that has a melting point of greater than 100°C the melting point of magnesium or magnesium alloy as defined in claim 12. Indeed, based on the teachings of Xiao, a POSITA would be motivated to select an aluminum alloy that includes an additive that has a melting point of less than 700°C to ensure that such additive fully melts in the molten magnesium or magnesium alloy. (Dr. Swanger Declaration - ¶¶ 42, 43).

Applicant submits that for at least the reasons set forth above, the combined teachings of Xiao and Hassan do not make obvious the limitations of independent claim 12. Applicant also submits that claims 13-16, 18-21, 23 and 24 which directly depend or indirectly depend on independent claim 12 are not obvious by the combined teachings of Xiao and Hassan.

4. Dependent Claim 13

Dependent claim 13 further includes limitations that are not taught or made obvious by the combined teachings of Xiao and Hassan. Dependent claim 13 requires that the additive material be added to said magnesium or magnesium alloy while the magnesium or magnesium alloy is at a temperature that is above the solidus temperature of the magnesium and a temperature that is less than a melting point of the additive material to form said mixture.

On Page 13 of the NFOA, the Examiner stated that Xiao teaches the limitation of claim 3, but does not identify any paragraph of Xiao for support of such assertion. On Pages 137-138 of the Request, Requester relied on paragraph 51 of the Dr. Medlin Declaration to assert that the limitations of claim 13 are taught by Hassan. Applicant notes that the Dr. Medlin Declaration is absent any discussion of claim 13. Applicant also notes that paragraph 51 of the Dr. Medlin Declaration merely relates to a Mg-Ni phase diagram, not to the limitations of claim 13.

As discussed above with regard to claim 12, Xiao teaches that all of the components of the alloy are melted. (Xiao - ¶ 22). As such, Xiao teaches away from the limitations claim 13. A POSITA would not look to the teachings of Xiao and Hassan regarding the limitations of claims 13. (Dr. Swanger Declaration - ¶ 82).

Applicant submits that for at least the reasons set forth above, dependent claim 13 is also not obvious in view of the combined teachings of Xiao and Hassan for these additional reasons.

5. Dependent Claims 15 and 20

Dependent claims 15 and 20 further include limitations that are not taught or made obvious by the combined teachings of Xiao and Hassan. Dependent claims 15 and 20, which ultimately depend on independent claim 12, require the additive material includes nickel, and wherein the nickel forms galvanically-active *in situ* precipitate in said magnesium composite.

As discussed above, Xiao does not teach that any particles in the magnesium alloy are formed by *in situ* precipitate. As such, Xiao does not teach the formation of *in situ* precipitate in the magnesium alloy, nor does Xiao teach that nickel forms *in situ* precipitate in the magnesium alloy when added to the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 34-54).

On Pages 19 and 20 of the NFOA, the Examiner did not address the limitation of dependent claims 15 and 20 with regard to the nickel forming galvanically-active *in situ* precipitate in the magnesium composite.

On Pages 139-141 and 144-147 of the Request, Requester asserted that Xiao would teach a POSITA that *in situ* precipitation formed of nickel create galvanically-active intermetallic phases or micro-batteries in the magnesium composite. The Requester does not appear to rely on any portions of the Dr. Medlin Declaration to support the assertion that claims 15 and 20 are obvious in view of the combined teachings of Xiao and Hassan. Applicant notes that in paragraph 108 of the Dr. Medlin Declaration, Dr. Medlin merely concluded that a POSITA would understand from Xiao that the additive formed *in situ* precipitate.

As discussed by Dr. Swanger, there is no teaching in Xiao that *in situ* precipitate is formed in the magnesium composite. (Dr. Swanger Declaration - ¶¶34-54). Furthermore, the assertions by Requester and Dr. Medlin are not supported by the teachings of Xiao. Xiao only teaches that magnesium and aluminum combine to form the micro-batteries in the magnesium alloy. There is

no teaching in Xiao that any other metal in the magnesium alloy forms micro-batteries. (Dr. Swanger Declaration - ¶¶34-54). Xiao only teaches that small additions of iron, copper, nickel, and silver can enhance the corrosion performance of the magnesium alloy. The mechanism by which such enhanced corrosion performance is accomplished is absent from Xiao. (Dr. Swanger Declaration - ¶¶ 34-54). Xiao only teaches that iron, copper, nickel, and silver can form micro-particles in the magnesium alloy that can improve corrosion performance of the magnesium alloy. (Dr. Swanger Declaration - ¶¶ 34-54).

Applicant submits that for at least the reasons set forth above, dependent claims 15 and 20 are also not obvious in view of the combined teachings of Xiao and Hassan for these additional reasons.

6. Dependent Claim 71

Dependent claim 71 further includes limitations that are not taught or made obvious by the combined teachings of Xiao and Hassan. Dependent claim 71, which ultimately depends on independent claim 49, requires at least a portion of the additive material remains unalloyed additive material in the magnesium composite.

On Page 21 of the NFOA, the Examiner acknowledged that Xiao does not teach such limitation; however, the Examiner asserted that such limitation is taught by Hassan. On Pages 150-151 of the Request, Requester asserted the limitation of claim 71 was taught by Hassan and that Dr. Medlin provides support for the motivation for a POSITA to combine the teachings of Hassan with Xiao. Dr. Medlin also asserted in paragraphs 402-408 of the Dr. Medlin Declaration that the limitations of claim 71 are obvious in view of the combined teachings of Xiao and Hassan.

As discussed above with regard to independent claim 12, there is no teaching in Hassan that a tertiary magnesium alloy that includes magnesium, aluminum, and zinc which can optionally

include a maximum content of nickel of 5 wt.%, would form unalloyed nickel precipitate or any other secondary unalloyed precipitate in the magnesium alloy of Xiao. (Dr. Swanger Declaration - ¶¶ 66, 68-70, 78, 81). Indeed, Xiao teaches against any of the additives in the magnesium alloy remaining unalloyed. (Xiao - ¶26).

Applicant submits that the very different binary MgNi alloys taught by Hassan do not teach or suggest to a POSTIA that unalloyed precipitate of iron, copper, nickel, and/or silver will form in the magnesium alloy of Xiao. (Dr. Swanger Declaration - ¶¶ 32, 33, 68-77, 81).

Applicant submits that for at least the reasons set forth above, the combined teaches of Xiao and Hassan do not make obvious the limitations of dependent claim 71.

Legal precedent requires a withdrawal of the rejection to claims 8, 7, 12-16, 18-21, 23-28, 33-36, 55, 58, 71 and 74-76 of the ‘795 Reexam under 35 U.S.C. § U.S.C. 103(a). Notice of the same is respectfully requested.

D. Secondary Considerations of Nonobviousness of the Claims of the ‘795 Reexam

Claims 1-5, 7-9, 11-16, 18-21, 23-50, 52-62, 64, 66, 67 and 69-76 of the ‘795 Reexam are allowable over Xiao and Hassan either alone, or in combination, as evidenced by the Objective Indicia of Non-Obviousness outlined in the Declaration of Andrew J. Sherman Under 37 C.F.R. § 1.132 dated January 8, 2022 (hereinafter, the “Sherman Declaration”).

As stated in the Sherman Declaration, the magnesium composites recited in claims 1-5, 7-9, 11-16, 18-21, 23-50, 52-62, 64, 66, 67 and 69-76 of the ‘795 Reexam exhibit objective indicia of non-obviousness over all known prior art due to (i) "long felt need" for the claimed invention, (ii) commercial success attributable to the claimed invention, (iii) industry praise of the claimed invention, (iv) unexpected results of the claimed invention, and (v) “copying” of the claimed

invention by others as delineated by the U.S. Supreme Court in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 4459, 467. (Sherman Declaration - ¶11-45; Dr. Swanger Declaration - ¶84). Such “[o]bjective evidence relevant to the issue of obviousness must be evaluated by Office personnel. Id. at 17-18, 148 USPQ at 467. Such evidence, [is] sometimes referred to as “secondary considerations.” MPEP 2141 II.

Specifically, as outlined in the Sherman Declaration, prior to the development of the claimed magnesium composites of the ‘795 Reexam, there was an understanding in the oil and well industry that dissolvable hydraulic fracturing equipment was needed to reduce costs and simplify operations. Despite over a decade of research and attempts at creating dissolvable materials that were useful for oil and well operations, no operationally viable product was ever produced, including any operationally viable cast magnesium alloys. In contrast, the cast magnesium alloys as defined in the claims of the ‘795 Reexam achieved immediate success after being released by the Terves LLC, the assignee of the ‘795 Reexam, as the magnesium composites fulfilled the unmet market need. The cast magnesium alloys of the ‘795 Reexam exhibited desired dissolution rates, the strength and durability required for frac plugs and frac balls necessary for effective use in oil and gas operations, and affordable manufacturing costs. The cast magnesium alloys produced in accordance to the ‘795 Reexam quickly reached about 100% market share of the dissolvable cast magnesium alloy market. (Sherman Declaration - ¶29-30).

This satisfaction of long felt need and success was confirmed by multiple industry rewards including an SPE Ingenious Award in 2015, two R&D 100 “Oscars of Innovation” finalist recognitions, a Petroleum Global Show innovation award, the 2015 Frost and Sullivan Manufacturing Leadership Award, and the 2014 Nortec Innovation Award among numerous other public and private recognitions. (Sherman Declaration - ¶31).

The success of the cast magnesium alloys as defined in the claims of the '795 Reexam was due to the unexpected properties exhibited by the magnesium composites, including higher strength and ductility than predicted by earlier AZ-type magnesium composites such as AZ91 magnesium alloys. The cast magnesium alloys exhibited very high dissolution rates of above 40 mg/cm²/hr. at 90°C in 3 wt.% KCl when formed with very low nickel concentrations (below 0.25 wt.%). The present application further discovered that the dissolution rate as a function of nickel concentration was not linear, but dependent on multiple factors including having grain boundaries in the right (Mg₂Ni phase) and the concentration of secondary elements. Additionally, the cast magnesium alloys enabled higher volumes and lower production costs than prior commercially available frac plugs and frac balls. (Sherman Declaration - ¶¶32-37).

The success and properties of the presently claimed magnesium composites has unfortunately led to direct copying by foreign corporations as evidenced by copycat magnesium samples found to be identical to those covered by one or more claims of the '795 Reexam. These samples were reverse engineered by third-party competitors and were being imported from China into the U.S. in violation of the claims of the present application. There are no known commercial formulations for manufacturing dissolvable wrought magnesium that would satisfy customer needs in the oil and gas industry, except the cast magnesium alloys covered by the claims of the '795 Reexam. (Sherman Declaration - ¶¶ 38-43).

Although there existed a prior art dissolvable magnesium alloy as disclosed in Xiao, third parties recognized that the Xiao magnesium alloy was an unacceptable alternative to the magnesium alloy covered by one or more claims of the '795 Reexam. Such copying by third-party infringers in light of the fact that there existed a potential prior art non-infringing U.S. alternative

is further evidence of the nonobviousness of the magnesium alloy defined in the claims of the '795 Reexam. (Sherman Declaration - ¶¶44, 45).

Applicant submits that collectively these secondary considerations in combination with Sherman Declaration illustrate that 1-5, 7-9, 11-16, 18-21, 23-50, 52-62, 64, 66, 67 and 69-76 of the '795 Reexam exhibit an objective indicia of non-obviousness over the teachings of Xiao and/or Hassan.

IV. CONCLUSION

For the reasons detailed above, it is submitted all the claims of the '795 Reexam are in condition for allowance.

Respectfully submitted,
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