

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Gary Schmit
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Title: LOW-FRICTION RECREATIONAL SLIDE SYSTEM

SUPPLEMENTAL DECLARATION OF DR. YOUJIANG WANG

I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

Dated: May 15, 2025

By: 
Dr. Youjiang Wang

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I. Introduction

1. I have been asked to provide a supplemental declaration addressing various statements advanced by Patent Owner and Patent Owner's declarants in this IPR proceedings.

2. In this supplemental declaration, I address two arguments advanced by Patent Owner. Although I believe that these arguments were generally addressed in my original declaration, I take this opportunity to clarify my statements and to provide further explanation with regard to aspects of the Patent Owner's arguments that I did not anticipate in my original declaration.

3. In particular, below I address the following arguments of the Patent Owner:

- (1) a person of ordinary skill would understand the commercial epoxies described in the '854 patent contain silicone or PTFE and would provide the lowest claimed range of frictional coefficients (Prelim. Resp., 59-60); and
- (2) it would be a simple and routine matter to determine how much lubricant should be added to obtain a mixture with the lowest claimed range of frictional coefficients based on the '854 patent description (Prelim. Resp., 60).

4. Additionally, I provide clarification related to these arguments regarding my statement that the POSITA would not have been able to achieve the claimed range of coefficients of friction (in particular the claimed 0.03-0.06 portion of the claimed range) by increasing the amount of lubricant and adding copper or another thermal conductor.

5. In the below explanation, I discuss three scientific papers which are relevant to the rebuttal of the arguments presented by the Patent Owner. These are:

- **UATP-1039** – Liu et al., *Preparation and Tribological Properties of Modified MoS₂/SiC/Epoxy Composites*, Materials 2021, 14, 1731
- **UATP-1040** – Brostow et al., *Modified Epoxy Coatings on Mild Steel: Tribology and Surface Energy*, European Polymer Journal, 2010, 46, 2181-2189
- **UATP-1041** – Kumar et al., *Tribological Studies of Epoxy Composites with Solid and Liquid Fillers*, Tribology International, 2017, 105, 27-36

6. UATP-1039 is an academic paper describing the results of a study in which epoxy composites were prepared with different amounts of surface-modified filler silicon carbide (SiC) particles and molybdenum disulfide (MoS₂) powder. UATP-1039, 1. UATP-1039 discusses that “friction and wear properties of modified MoS₂/SiC/EP composites are better than SiC/Ep composites without

modified MoS₂.” *Id.* UATP-1039 reports that friction coefficient value and volume wear rate of the composite decreases with increasing MoS₂ content up to 4% by weight, but above 4% by weight MoS₂, the measured friction coefficient and wear rate begin to increase. UATP-1039, 8-9.

7. UATP-1040 is an academic paper describing the modification of a commercial epoxy by adding a fluoropolymer and metal micro powders including Ni, Al, Zn, and Ag. UATP-1040, 1-2. UATP-1040 reports on the effects of curing temperature and curing agent, as well as particle shape-effects, on tribological properties of the composite including on dynamic friction and wear. *Id.*

8. UATP-1041 is an academic paper describing characteristics of epoxy composites with filler materials including graphene and graphite, as well as liquid lubricants. UATP-1041, 1. UATP-1041 reports that “[a]mong all coatings, epoxy filled with graphene and SN150 lubricant provided the lowest coefficient of friction of 0.09.” UATP-1041, 1. UATP-1041 further provides a literature review of epoxy composites with mixed lubrication regimes. UATP-1041, 1-3.

9. Each of these scientific papers provides context for what a POSITA would have understood about commercial epoxies and epoxy composited including lubricant materials as of the Critical Date. See UATP-1042 (addressing public availability of UATP-1039, UATP-1040, and UATP-1041).

10. Although epoxy composites that incorporate both solid and liquid lubricants do not directly read on the claimed dry lubricant coating, these references provide insight into the considerations that a POSITA would have understood need to be accounted for in preparing an epoxy composite and the various factors that impact measured coefficients of friction of an epoxy composite that make it impossible to theoretically determine an appropriate filler amount to achieve a desired friction coefficient. Contrary to Patent Owner's arguments, a POSITA would not have been able to determine how much lubricant should be added to obtain a mixture with the lowest claimed range of frictional coefficients based on theory, and there is no indication that a POSITA could have done so experimentally without significant experimentation.

II. A POSITA would not have understood that the commercial epoxies described in the '854 patent would have the claimed frictional coefficient range of 0.03-0.06

11. I understand that in Patent Owner's Preliminary Response, Patent Owner argued that "[t]he '854 patent describes commercial epoxies containing silicone or PTFE for coating the slide [and a] POSITA would understand these commercial epoxies suggested by the '854 patent for use in the slide coating would provide the lowest claimed range of frictional coefficients." Prelim. Resp., 59-60. Patent Owner's Declarant, Dr. Spiegelberg, echoes this argument, adding that the commercial epoxies suggested in the '854 patent "contain additional components

that temper the low friction properties of included lubricants.” See EX2026, ¶255. This statement acknowledging the influence of other components of the epoxy composite on friction characteristics is at odds with Dr. Spiegelberg’s next sentence which states that “the ’854 patent states ‘[t]he lubricity of the dry coating 34 and the resulting coefficient of friction between the slide surface 18 and the ride vehicle is primarily influenced by the lubricant present in the dry lubricant material,’ such that a POSITA would have understood that the frictional coefficient is not in any significant way influenced by other materials present in the coating.” EX2026, 122 (quoting UATP-1001, 7:36-39 without citation). Not only does Dr. Spiegelberg’s first statement contradict the second, but additionally, the Dr. Spiegelberg’s conclusion that a POSITA would understand that the frictional coefficient is “not in any significant way” impacted by the presence of other materials in the dry lubricant coating does not follow from the ’854 patent’s disclosure that the lubricant primarily influences the friction and further is not supported by the literature that would have been well-known to a POSITA by the Critical Date. See *e.g.*, UATP-1039, UATP-1040, UATP-1041. Further, the ’854 patent’s reference to the presence of an unknown amount of silicone or PTFE in the commercial epoxies—without any mention of an expected friction coefficient of the epoxy itself—would not have indicated to a POSITA that the listed commercial epoxies have a particular coefficient of friction, contrary to Patent

Owner's claim. See Prelim. Resp., 59-60 ("A POSITA would understand these commercial epoxies suggested by the '854 patent for use in the slide coating **would provide the lowest claimed range of frictional coefficients.**").

12. For these reasons, I disagree with Patent Owner's statement and Declarant's supporting explanation.

13. First, the '854 patent describes:

[T]he formulation for the dry lubricant material that is applied to the slide is a mixture comprising the following: (i) a resin, (ii) a lubricant, (iii) a thermal conductor, and (iv) a hardener, otherwise referred to as a hardening or curing agent...In the embodiment shown, the resin is an epoxy (i.e., epoxide) resin such as Steelflex Epoxy #9X commercially available from Fasco Epoxies Inc (Fort Pierce, PL), for example. In another embodiment, the resin may be a silicone based polymeric material such as Wearlon-A (e.g., a mixture or blend of epoxy silicone emulsion, 2-propoxy-ethanol, water, and clay filler) or a PTFE based epoxy material such as Wearlon-B (e.g., a mixture or blend of polyethylene polyamine adduct, 2-propoxyethanol, methyl alcohol, water, and epoxy polytetrafluoroethylene emulsion), both of which are commercially available from Plastic Maritime Corporation (Wilton, NY). To this end, the resin may include silicone or polytetrafluoroethylene (PTFE). In an alternative embodiment, the resin may be a polyester based resin or a polyvinylfluoride based resin, for example. UATP-1001, 7:13-35.

14. Though the '854 patent describes that there are various examples of commercially available epoxies that may be used as the resin in the dry lubricant, and that some of these may already include some amount of silicone or PTFE, **there is no suggestion** in the '854 patent that these commercial epoxy products would possess the claimed frictional coefficient range of 0.03-0.06. The '854

patent simply does not provide any coefficient of friction value associated with the commercial epoxies listed therein.

15. Second, I have been unable to find any documentation of coefficients of friction measured for these commercial epoxies mentioned in the '854 patent, and certainly no documentation to indicate their frictional coefficient would fall within the claimed range of 0.03-0.06. In view of the lack of such a coefficient of friction value for the commercial epoxies described in the '854 patent or in available literature related to the particular listed commercial epoxies, a POSITA would not have had any knowledge of a particular frictional coefficient value associated with the commercial epoxies listed in the '854 patent.

16. Indeed, a POSITA **would not have expected** the commercial epoxy products to have a coefficient of friction in the “lowest claimed range of frictional coefficients” based on the knowledge of the POSITA as supported in the scientific literature available by the Critical Date. As I described in my declaration (UATP-1003), very few materials are known to have a coefficient of friction in this low range (i.e., in the lowest part of the claimed range from 0.03-0.06), and those materials have that coefficient of friction only under particular conditions. See UATP-1003, ¶¶41 (citing UATP-1028, 1 and UATP-1008, 4-5), 114 (describing the lowest theoretical frictional coefficient achievable in physical systems and citing UATP-1028, 1), 282-284 (describing that the lowest theoretical values are

only achieved in systems involving ice and snow). Unlike the ideal conditions involving ice and snow that may give rise to the lowest range of frictional coefficients, a POSITA would have understood that under normal conditions “epoxy is a poor tribological material.” UATP-1041, 1; *see also* UATP-1039, 1 (“due to [epoxy’s] three-dimensional network structure and poor surface properties, [epoxy] cannot be directly used as a wear-resistant material.”).

17. Commercial epoxies designed for particular applications, such as coatings for watercraft and aircraft may include added fillers like silicone or PTFE to provide a lower coefficient of friction (against air, water, or biofouling materials, for example), but a POSITA would not have expected even these commercial epoxies to have coefficients of friction in the 0.03-0.06 range, contrary to Patent Owner’s claim. *See* UATP-1039, 8 (Fig. 5B showing 100% by weight commercial epoxy with measured average friction coefficient of about 0.53, Fig. 5D showing commercial epoxy with optimized SiC and MoS₂ lubricant filler content with measured average friction coefficient of about 0.42); UATP-1040, 5 (Figs. 2-3 showing average pin-on-disc friction measurement for unmodified epoxy of about 0.35 and epoxy composite with optimized metal particle content with pin-on-disc friction measurement of about 0.1); 6 (Figs. 4-5 showing average pin-on-disc friction measurement for unmodified epoxy of about 0.175 and epoxy composite with optimized metal particle content with pin-on-disc friction

measurement of about 0.25); UATP-1041, 8 (Fig. 8a showing coefficient of friction for epoxy composites including both metal and liquid lubricant fillers between about 0.08 and 0.2). Based on the reports in the scientific literature before the critical date, a POSITA would have understood that even with the addition of fillers to improve the coefficient of friction, only modest improvements to friction coefficient of an epoxy composite would have been expected.

III. It would not have been simple or routine for a POSITA to determine how much lubricant to add to a commercial epoxy to obtain the claimed frictional coefficient range of 0.03-0.06

18. I understand that in Patent Owner's Preliminary Response, Patent Owner argued that "[i]t would be a simple and routine matter for a POSITA to determine how much additional lubricant should be added to obtain a mixture that would have a coefficient of friction with a mesh ride vehicle between 0.03-0.06." Prelim. Resp., 60. Patent Owner's Declarant, Dr. Spiegelberg, echoes this argument, stating that "given th[e] direction from the '854 patent [that 'lubricant is mixed into the resin ... to increase the amount of lubricant in the coating material'], it would be a simple and routine matter for a POSITA to determine how much additional lubricant should be added to obtain a mixture that would have a coefficient of friction with a mesh ride vehicle between 0.03-0.06." See EX2026, ¶256. Regardless of whether Patent Owner and Dr. Spiegelberg intend to say that it would have been a simple and routine matter for a POSITA to make this

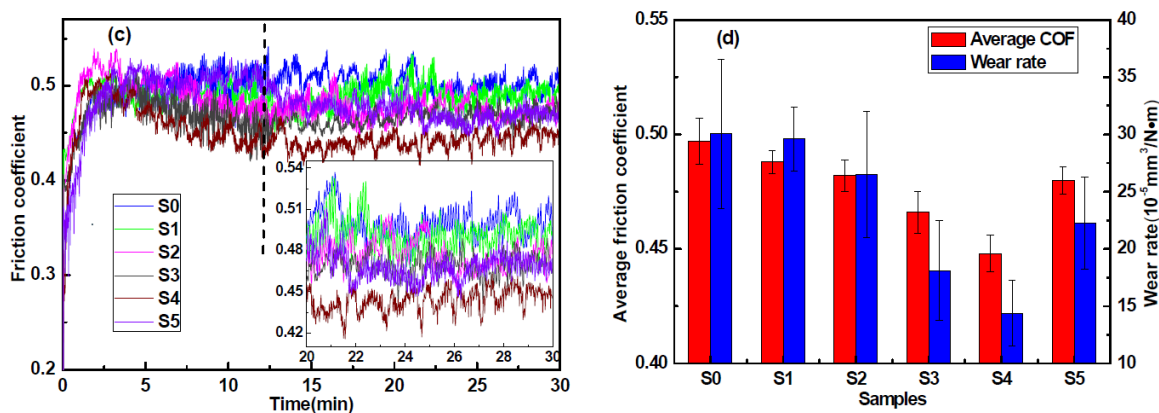
determination theoretically or experimentally, I disagree with Patent Owner's statement.

A. *A POSITA would not have been able to “determine how much lubricant to add” to an epoxy to achieve a desired friction coefficient*

19. First, it is not true to say that one can calculate based on theory the amount of lubricant to be added to an epoxy to achieve a particular frictional coefficient, as Patent Owner has admitted. *See* Prelim. Resp., 38 (“coefficient of friction is a property that depends on more than just the chemistry of the two surfaces”); *see also* EX2026, ¶171. A POSITA would have been aware of the various factors that influence a coefficient of friction between two materials. *See e.g.*, UATP-1027, 1; UATP-1003, ¶42. The coefficient of friction is not simply dictated by the composition of the material, but also depends on macro and micro surface characteristics, interlayer characteristics, temperature, and other environmental conditions, as well as testing conditions. *See e.g.*, UATP-1041, 3, 5-6; UATP-1040, 1, EX2026, ¶171.

20. These additional factors that influence a coefficient of friction measured between two surfaces mean that a POSITA cannot theoretically derive or determine a lubricant content of a composite that would have a desired frictional coefficient. For example, as illustrated in UATP-1039, Figs. 5C-5D, a linear increase in the MoS₂ content present in an MoS₂/SiC/EP composite (*see* UATP-

1039, table 1, reproduced below including the ingredients of the labeled epoxy composites) does not have a predictable linear effect (or other predictable effect) on the friction coefficient of the composite that would allow for theoretical derivation of friction coefficient from composite composition. UATP-1039, 8. The composite including 4% MoS₂ (“S4;” depicted in brown) has a lower coefficient of friction than the composite including 5% MoS₂ (“S5;” depicted in purple). *Id.*, 8, 9 (“When the content of modified MoS₂ continued to increase, the average COF and volume wear rate of the modified MoS₂/SiC/EP composites increased”). Additionally, in the early regime depicted in Fig. 5C, the 5% MoS₂ composite measured some of the highest friction coefficient values. *Id.* This unpredictability of the performance of a particular composite based on content alone illustrates that a POSITA would not have been able to determine an amount of lubricant filler to be added to an epoxy to attain a desired frictional coefficient.



UATP-1039, FIGS. 5C (left) and 5D (right)

Table 1. Ingredients of epoxy composites.

Sample	Fillers (wt.%)		EP (wt.%)
	SiC	MoS ₂	
EP	0	0	100
SE	50	0	50
S0	55	0	45
S1	54	1	45
S2	53	2	45
S3	52	3	45
S4	51	4	45
S5	50	5	45

UATP-1039, Table 1

21. Indeed, UATP-1039 explains that it is important to have “the appropriate amount” of lubricant filler in an composite to optimize friction and wear characteristics without having excess, weakly-bonded, lubricant particles to decrease these properties. UATP-1039, 12. A POSITA would have understood that such an “appropriate amount” cannot be determined theoretically, and can only be determined with significant experimentation.

B. A POSITA would have been aware of additional requirements and considerations for adding lubricant fillers to epoxies

22. Second, it is neither “simple” nor “routine” to add lubricant to an epoxy to achieve a particular frictional coefficient because adding components to an epoxy composite changes more than just the frictional coefficient of the composite. UATP-1003, ¶¶284-286. Either determination of an amount of filler

by theory (which as I explained above is not possible) or experimentally determining an amount of filler to achieve a desired coefficient of friction would need to not only add lubricants but also adjust amounts of other components and/or processing methods to achieve a workable lubricant coating for use with a recreational slide. A POSITA would have been aware that producing a compound using a commercial epoxy and a lubricant (in addition to a hardener and thermal conductor) would require more than simply mixing a lubricant into a vessel of epoxy – and the '854 patent provides no guidance on how to account for such additional considerations.

23. Indeed, UATP-1039 plainly states that “[d]ue to the significant differences in chemical structure and physical form, a lack of affinity between inorganic fillers and [epoxy] resin, ***surface modification of fillers is essential to make them combine better*** with polymer and have good dispersion, ***especially when the filler content is higher***, which cannot be well dispersed in the polymer, even though mechanical stirring.” UATP-1039, 3. A POSITA would have understood that in many if not most cases, the addition of fillers to an epoxy would require surface modification of the filler particles to aid in dispersion of the particles in the epoxy for the very reasons stated in UATP-1039. See UATP-1039, 1 (describing the addition of surface-modified MoS₂ particles to epoxy), 3, 7 (“The dispersion uniformity of fillers in the epoxy resin matrix directly affects the

performance of the EP composites [and] this effect will be more significant when the filler is added in a large proportion.”). For example, UATP-1039 describes that in experiments, MoS₂ particles were added to an epoxy after being “modified by the silane coupling agent KH560 to improve dispersion and avoid agglomeration of the inorganic particles in the EP resin matrix.” *Id.*, 1. The KH560 modification of the MoS₂ improves wettability and dispersion of the particles. *Id.*, 3.

24. However, a POSITA would have also understood that surface modification of lubricant particles such as MoS₂ is not a simple matter and that “particle size, ... specific surface area, and ... surface energy” of the MoS₂ particles also impact the bonding strength between lubricant particles and the epoxy resin and further impact the “contact area of the friction pair on the surface of the composites,” as UATP-1039 teaches. UATP-1039, 9; *see also* UATP-1040 (“during slow curing the FPEK migrates to the free surface since the surface energy of the fluoropolymer is lower than that of pure epoxy”). UATP-1041 for example, describes that “graphene is more effective in improving the mechanical properties of epoxy [than graphite] because of smaller size of the graphene particles” leading to better bonding between graphene and epoxy in the composite. UATP-1041, 4; *see also* EX2026, ¶171 (agreeing that a coefficient of friction “depends on more than just the chemistry of the two surfaces, [and also] depends upon the morphology of the surfaces”).

25. Additionally, a POSITA would have understood that the addition of fillers for the purpose of improving tribological performance can have unexpected consequences on other characteristics of the compound, such as decreasing mechanical hardness or flexural strength relative to un-filled epoxy. UATP-1041, 1; UATP-1039, 9 (hardness of the composite decreased with increasing content of surface-modified MoS₂). For example, UATP-1039 describes determining a total content of fillers beyond which the average measured friction coefficient and volume wear rate does not change. UATP-1039, 9. This illustrates what a POSITA would have understood – that there is likely a saturation point after which the addition of more lubricant particles (or other particles) does not affect (or marginally affects) on the tribological properties of the composite. A POSITA would have been further aware that there may also be an amount of added fillers that actually begins to decrease tribological or mechanical performance of the composite. *See e.g.*, UATP-1039, 8-9 (describing that addition of surface-modified MoS₂ particles to a MoS₂/SiC/EP composite beyond 4% by weight actually **increased** measured COF and volume wear compared to lower added amounts, keeping the total amount by weight of added fillers constant). A POSITA would not have known what this saturation point or decreasing performance point is without experimenting to determine it – and would not have had any indication of

what that saturation point is or how to determine it from the disclosure of the '854 patent.

26. The '854 patent describes “the lubricant is mixed into the resin described above to increase the amount of lubricant in the coating material” (UATP-1001, 7:46-48) and that “[t]he dry lubricant material... is prepared by mixing the components together using any conventional mixing apparatus” (UATP-1001, 9:8-10). In some cases, “the lubricant and the thermal conductor are mixed into or blended into a solvent carrier... to form a first intermediate mixture [which] is then mixed or blended into the resin to form a second intermediate mixture [which] is then mixed or blended with the hardening or curing agent to form the dry lubricant material which can then be applied to the slide surface.” UATP-1001, 9:11-18. This is hardly a “roadmap” for how to navigate determining an appropriate amount of lubricant to add in order to achieve frictional coefficients in the lowest claimed range, and the '854 patent’s treatment of the preparation of the dry lubricant coating, along with Patent Owner’s statement, disregard the additional considerations and problems in adding fillers (like lubricants and thermal conductors) to epoxies of which a POSITA would have been aware.

C. A POSITA would have been aware of additional requirements and considerations for adding thermal conductor fillers to epoxies

27. In addition to the considerations for adding lubricant fillers to epoxy composites, a POSITA would have recognized that the addition of thermal conductors, for example metal particles, to an epoxy composite also requires consideration of a variety of factors that influence tribological and mechanical characteristics of the composite. *See e.g.*, UATP-1040, 2 (“It has been reported in literature that **curing temperature has a significant effect** on a variety of properties – especially mechanical ones, **friction**, tensile bond strength, electrical resistivity, etc. of cured epoxies”); *compare id.*, Fig. 3 (showing pin-on-disc friction measurements for epoxy composites with TETA curing agent), *with id.*, Fig. 5 (showing pin-on-disc friction measurements for epoxy composites with HMDA curing agent); *see also id.*, 6 (“Since the coatings were prepared in a laboratory atmosphere, there was a chance of **formation of a new secondary phase** within the metal powders like a metal oxide phase **which would affect the tribological properties of the final coating**”), 7 (“Samples containing Zn show high friction in both cases – clearly because of the presence of ZnO phase along with Zn phase [and a]lso the **morphology of the Zn and ZnO particles is responsible for high friction**...[the low friction of Al-containing samples compared to others] can be explained by spherical morphology of Al particles

which results in rolling friction”), 8 (“**increasing trend of surface energy and friction with increasing curing temperature**”). For example, UATP-1040 describes that performance of epoxies can be improved “by introducing a metallic dispersed phase” which may lead to “significant improvement in thermal properties of polymers.” UATP-1040, 1. However, UATP-1040 illustrates that the incorporation of such metal materials into an epoxy composite is not as straightforward as suggested by the ’854 patent and the Patent Owner, and a POSITA would have understood this well-known fact. UATP-1040, 2 (describing different shapes of metal particles added to epoxy composite).

IV. Conclusion

28. For the reasons described above, I disagree with the Patent Owner’s claims that (1) a person of ordinary skill would understand the commercial epoxies described in the ’854 patent contain silicone or PTFE and would provide the lowest claimed range of frictional coefficients; and (2) it would be a simple and routine matter to determine how much lubricant should be added to obtain a mixture with the lowest claimed range of frictional coefficients based on the ’854 patent description.

29. Instead, it is my professional opinion that a POSITA **would not** have understood the commercial epoxies listed in the ’854 to provide the lowest claimed range of frictional coefficients, because there is no evidence in the ’854 patent or

elsewhere that I am aware of to support this claim, and because these lowest range coefficients of friction are only attainable with materials that are not suitable for a slide or in pure materials under ideal conditions. *See* UATP-1003, ¶¶283-285. A POSITA would have understood that epoxies generally have much higher coefficients of friction than the claimed lowest range, even in the presence of lubricant compounds. *See e.g.*, UATP-1039, 8 (Figs. 5B, 5D); UATP-1040, 5 (Figs. 2-3), 6 (Figs. 4-5); UATP-1041, 8 (Fig. 8a).

30. Further, it is my professional opinion that a POSITA would not have found it “a simple and routine matter” to determine an amount of lubricant to add to a commercial epoxy to attain the lowest range of claimed frictional coefficients. *See* UATP-1003, ¶¶286-287. A POSITA would have recognized that, first, it is not possible to make this determination based on theory, and second, the determination of an appropriate amount of lubricant filler to add is confounded by additional considerations such as how to achieve sufficient dispersion in the epoxy composite, accounting for surface energy and morphology considerations, saturation point, interaction with and impact of other components of the composite on the friction coefficient of the epoxy composite, and maintaining other desirable material characteristics like wear resistance and hardness, as I described above.

31. Accordingly, in view of my explanation of the relevant literature at the Critical Date above, it remains my professional opinion that claims 8-13 are not enabled by the '854 patent.