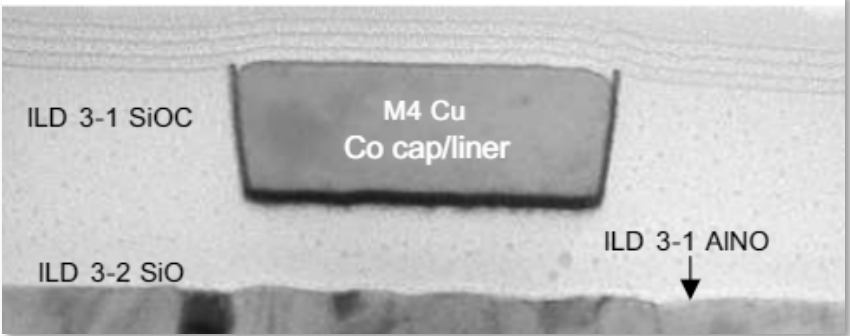
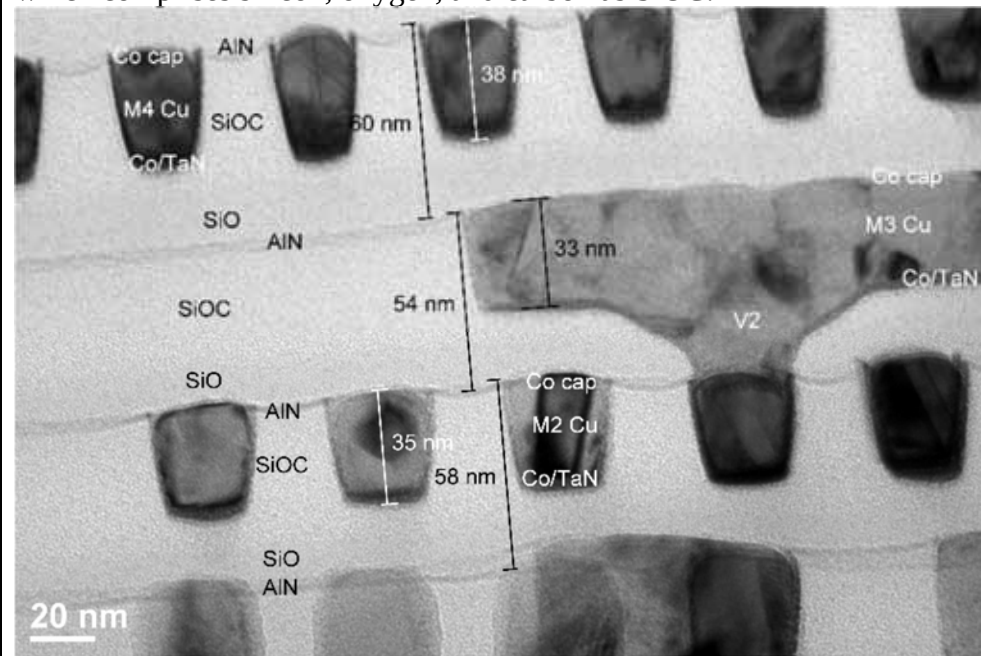


EXHIBIT C
(INFRINGEMENT OF U.S PATENT NO. 10,727,183)

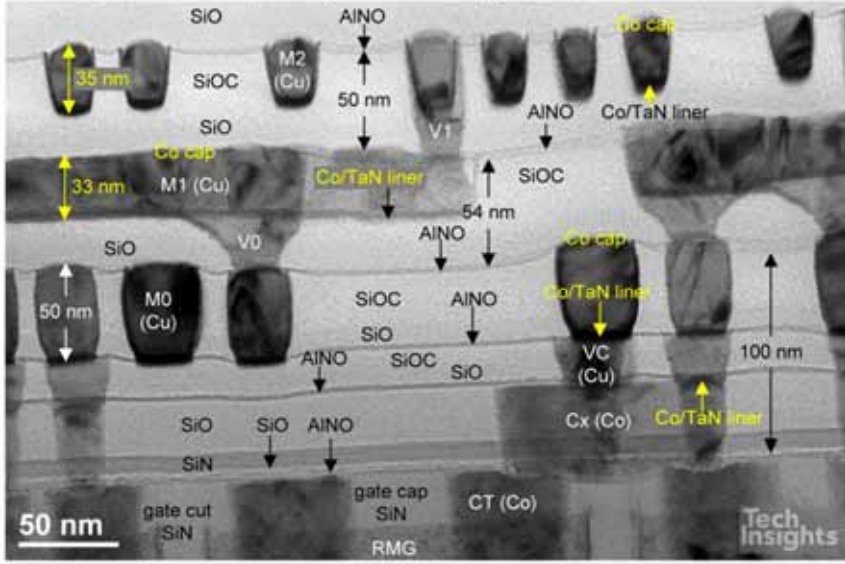
#	Claim Language	Accused Instrumentalities
1.1	1. An integrated circuit structure, comprising:	To the extent the preamble of Claim 1 is limiting, each of the '183 Patent Accused Products, including for example the Snapdragon 835 – 10nm microprocessor, comprises an integrated circuit structure.
1.2	a dielectric layer having an upper surface, the dielectric layer comprising silicon, oxygen and carbon;	Each of the '183 Patent Accused Products comprises a dielectric layer having an upper surface, the dielectric layer comprising silicon, oxygen and carbon. For example, the Snapdragon 835 – Samsung 10nm microprocessor includes a layer, shown as ILD 3-1 in the figure below, comprises silicon, oxygen and carbon as SiOC.¹⁷⁹ 

¹⁷⁹ TechInsights Report ACE-1704-802, p.20.

Also for example, the Samsung Exynos 990 – 7 nm microprocessor includes layers, each of which comprises silicon, oxygen, and carbon as SiOC:¹⁸⁰

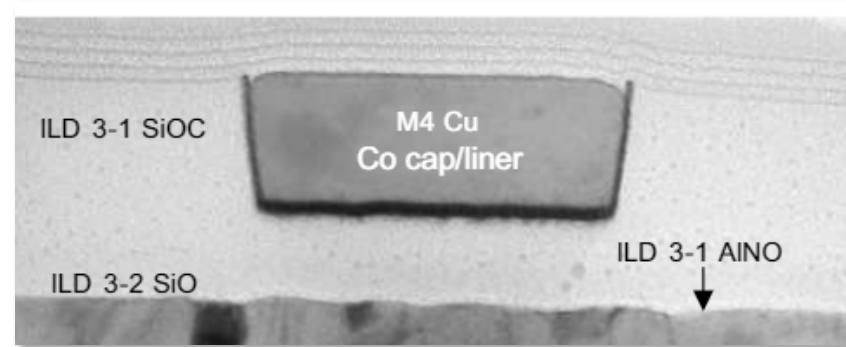


¹⁸⁰ TechInsights Report ACE-2003-801, p.44.

#	Claim Language	Accused Instrumentalities
		Also for example, the Snapdragon 888 - 5 nm processor comprises interlayer dielectric layers over the substrate, comprising silicon, oxygen, and carbon, shown as SiOC in the figure below.  181
1.3	a conductive structure in the dielectric layer, the conductive structure comprising:	Each of the '183 Patent Accused Products comprises a conductive structure in the dielectric layer.

¹⁸¹ TechInsights Report ACE-2101-801, p.46.

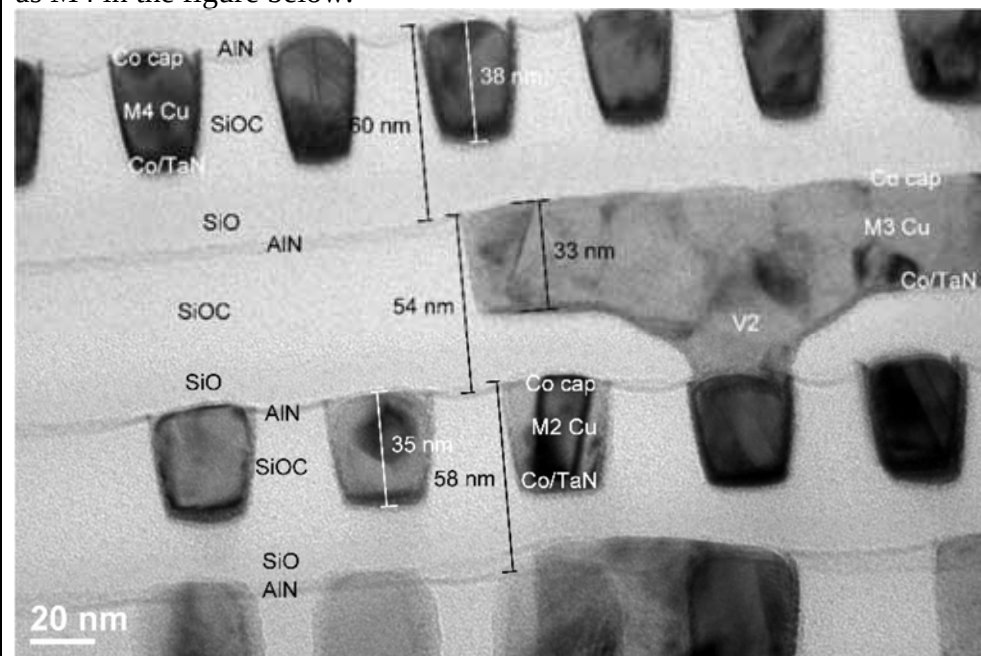
For example, the Snapdragon 835 – 10nm microprocessor comprises a conductive structure in the dielectric layer, the conductive structure comprising copper and cobalt, labeled as M4 in the figure below.¹⁸²



Also for example, the Samsung Exynos 990 - 7 nm microprocessor comprises a conductive structure in the dielectric layer, the conductive structure comprising copper and cobalt, labeled

¹⁸² TechInsights Report ACE-1704-802, p.20.

as M4 in the figure below:¹⁸³

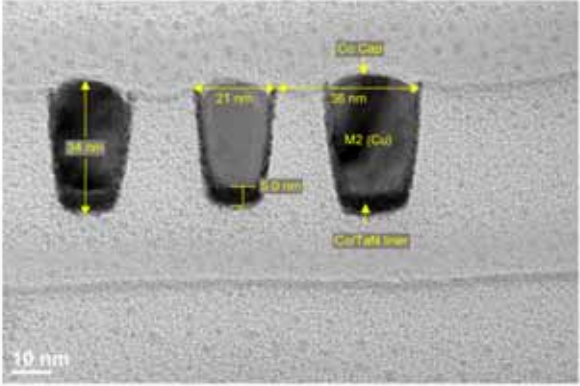


Also for example, the Snapdragon 888 - 5 nm processor comprises a conductive structure in the dielectric layer, the conductive structure comprising copper and cobalt,¹⁸⁴ as shown for M2 in the figure below:¹⁸⁵

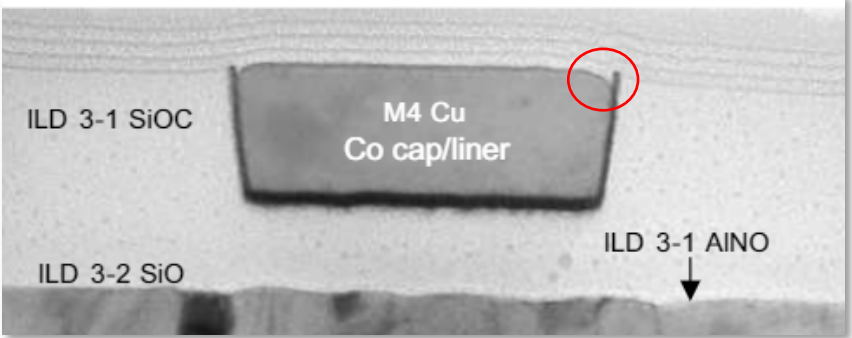
¹⁸³ TechInsights Report ACE-2003-801, p.42.

¹⁸⁴ TechInsights Report ACE-2003-801, p.8.

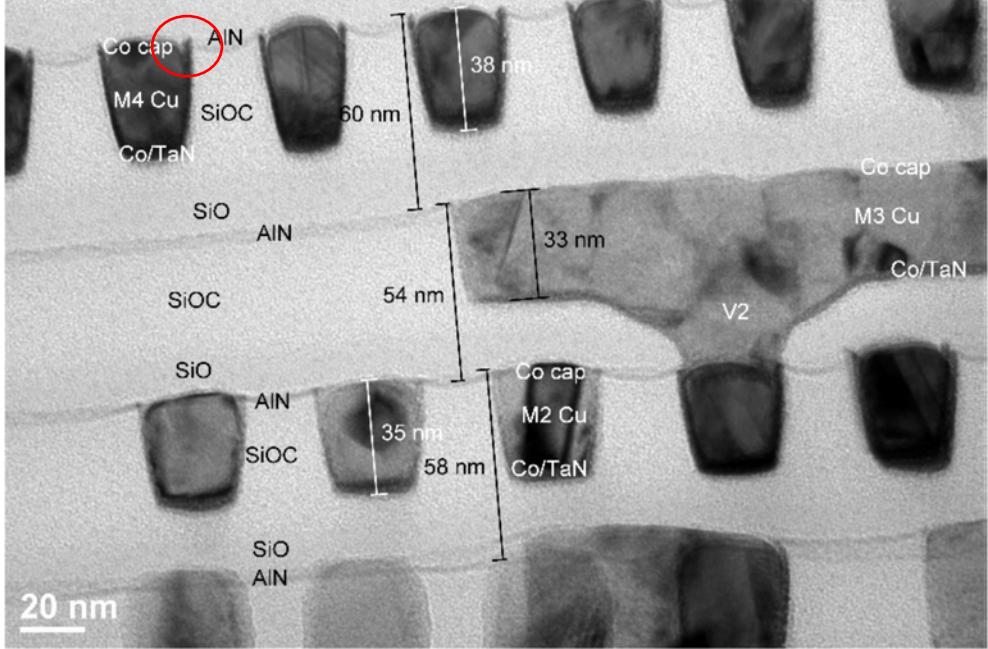
¹⁸⁵ TechInsights Report ACE-2101-801, p.42.

#	Claim Language	Accused Instrumentalities
		 M2 180k b_379858.png
1.4	a first conductive material comprising copper, the first conductive material having an upper surface, with a portion of the upper surface of the first conductive material below a portion of the upper surface of the dielectric layer; and	In each of the '183 Patent Accused Products, the conductive structure comprises a first conductive material comprising copper, the first conductive material having an upper surface, with a portion of the upper surface of the first conductive material below a portion of the upper surface of the dielectric layer. For example, the Snapdragon 835 – 10nm microprocessor comprises a conductive structure in the dielectric layer, the conductive structure further comprising a first conductive material comprising copper, the first conductive material having an upper surface, with a portion of the upper surface of the first conductive material below a portion of the upper surface of the dielectric layer. On information and belief, a portion of the conductive material comprising copper forms a divot that falls a distance below the upper surface of the dielectric layer (circled in red).¹⁸⁶

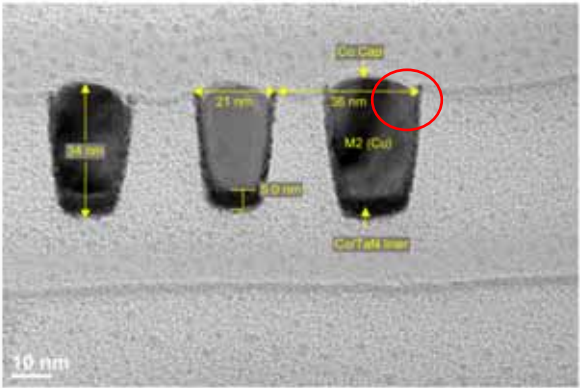
¹⁸⁶ TechInsights Report ACE-1704-802, p.20.

#	Claim Language	Accused Instrumentalities
		 Also for example, the Samsung Exynos 990 - 7 nm microprocessor comprises a conductive structure in the dielectric layer, the conductive structure further comprising a first conductive material comprising copper, the first conductive material having an upper surface, with a portion of the upper surface of the first conductive material below a portion of the upper surface of the dielectric layer. On information and belief, a portion of the conductive material comprising copper forms a divot that falls a distance below the upper surface of the dielectric layer (circled in red):¹⁸⁷

¹⁸⁷ TechInsights Report ACE-2003-801, p.44.

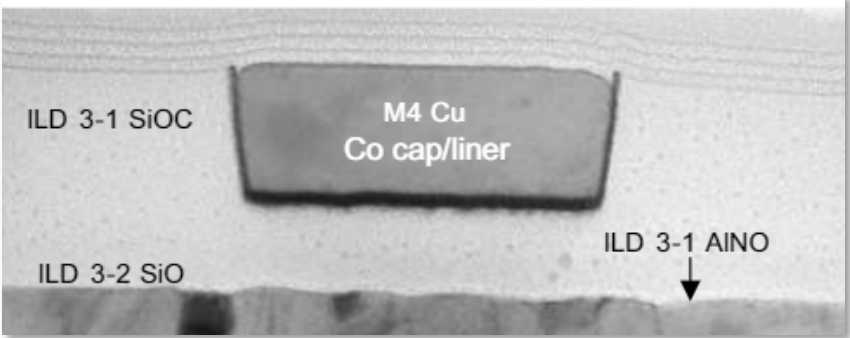
#	Claim Language	Accused Instrumentalities
		 Also for example, the Snapdragon 888 - 5 nm processor comprises a conductive structure in the dielectric layer, the conductive structure further comprising a first conductive material comprising copper, the first conductive material having an upper surface, with a portion of the upper surface of the first conductive material below a portion of the upper surface of the dielectric layer.¹⁸⁸ On information and belief, a portion of the conductive material comprising

¹⁸⁸ TechInsights Report ACE-2101-801, pp.8, 42.

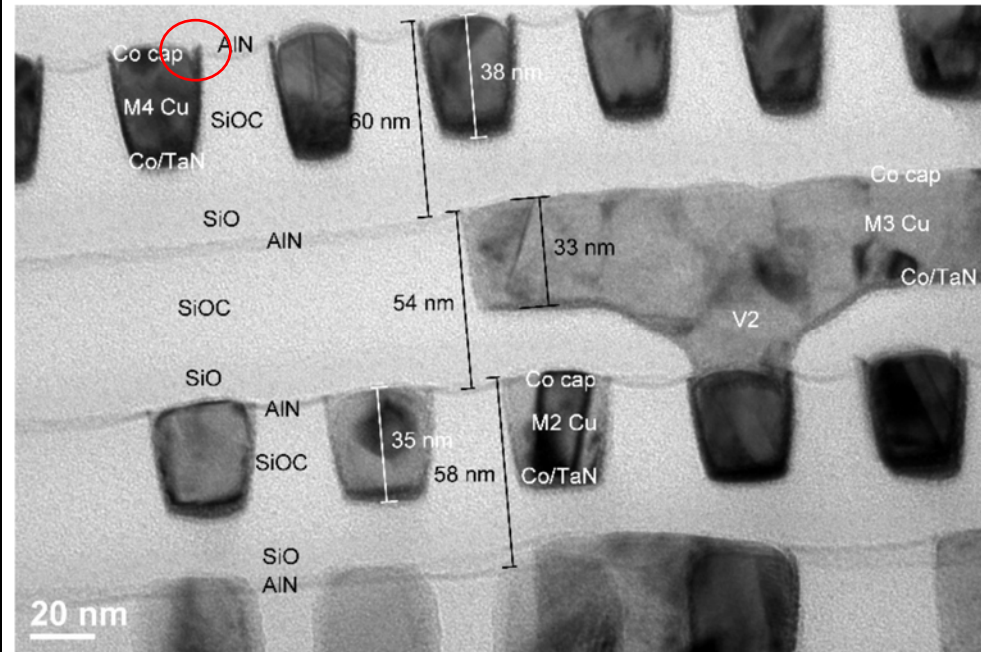
#	Claim Language	Accused Instrumentalities
		copper forms a divot that falls a distance below the upper surface of the dielectric layer (circled in red), as shown for M2 in the figure below:¹⁸⁹  M2 180k b_379858.png
1.5	a second conductive material on the upper surface of the first conductive material, the second conductive material comprising cobalt, wherein the first conductive material and the second conductive material have a same width at a location where the first conductive material and the second conductive material meet, wherein the second conductive material has an	In each of the '183 Patent Accused Products, the conductive structure comprises a second conductive material on the upper surface of the first conductive material, the second conductive material comprising cobalt, wherein the first conductive material and the second conductive material have a same width at a location where the first conductive material and the second conductive material meet, wherein the second conductive material has an upper surface having a portion substantially co-planar with the portion of the upper surface of the dielectric layer, and wherein the upper surface of the second conductive material has a curved corner below the portion of the upper surface of the dielectric layer. For example, in the Snapdragon 835 – 10nm microprocessor the second conductive material is a cobalt capping layer on top of the copper conductive material. The divot forms a curved corner.¹⁹⁰

¹⁸⁹ TechInsights Report ACE-2101-801, p.42.

¹⁹⁰ TechInsights Report ACE-1704-802, p.20.

#	Claim Language	Accused Instrumentalities
	upper surface having a portion substantially co-planar with the portion of the upper surface of the dielectric layer, and wherein the upper surface of the second conductive material has a curved corner below the portion of the upper surface of the dielectric layer; and	

Also for example, in the Samsung Exynos 990 - 7 nm microprocessor, the second conductive material is a cobalt capping layer on top of the copper conductive material. The divot forms a curved corner:¹⁹¹

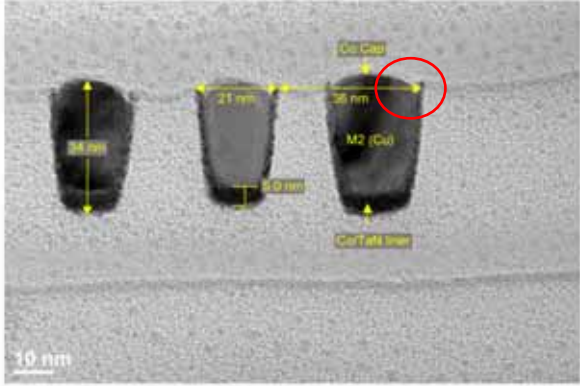


Also for example, in the Snapdragon 888 - 5 nm processor, the second conductive material is a cobalt capping layer on top of the copper conductive material.¹⁹² The divot forms a curved corner:¹⁹³

¹⁹¹ TechInsights Report ACE-2003-801, p.44.

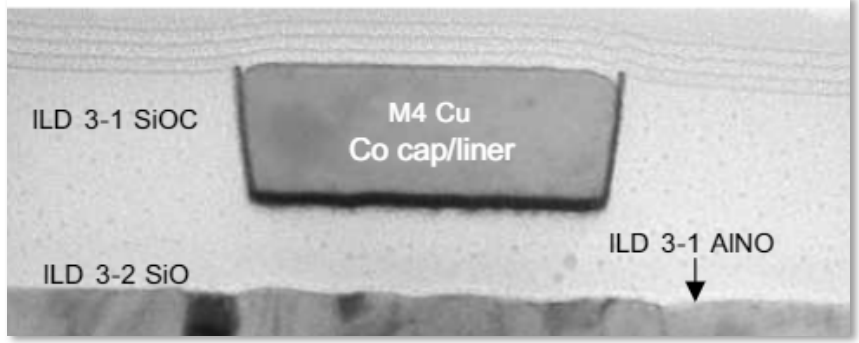
¹⁹² TechInsights Report ACE-2101-801, p.8.

¹⁹³ TechInsights Report ACE-2101-801, p.42.

#	Claim Language	Accused Instrumentalities
		 M2 180k b_379858.png
1.6	a barrier layer partially surrounding the conductive structure, the barrier layer comprising tantalum.	Each of the '183 Patent Accused Products comprises a barrier layer partially surrounding the conductive structure, the barrier layer comprising tantalum. For example, the barrier layer in the Snapdragon 835 – Samsung 10nm microprocessor is Tantalum-based. Also for example, the barrier layer in the Samsung Exynos – 7 nm microprocessor is Tantalum-based.¹⁹⁴ Also for example, the barrier layer in the Snapdragon 888 - 5 nm processor is Tantalum-based.¹⁹⁵
2.1	2. The integrated circuit structure of claim 1,	See Claim 1, above.
2.2	wherein the barrier layer further comprises nitrogen.	On information and belief, the barrier layer in each of the '183 Patent Accused Products further comprises nitrogen.

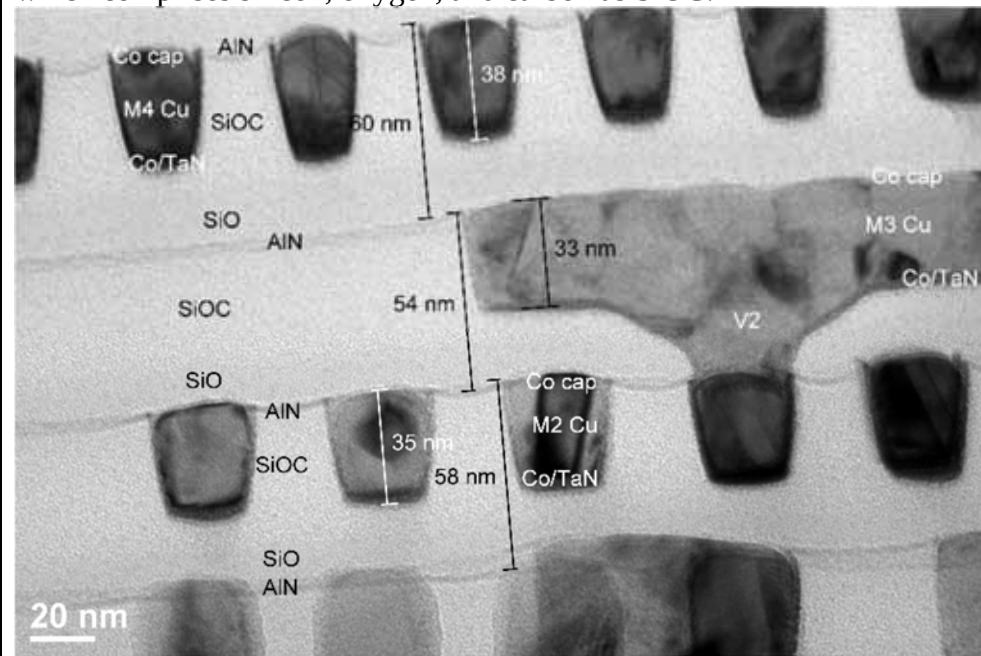
¹⁹⁴ TechInsights Report ACE-2003-801, pp.8, 40.

¹⁹⁵ TechInsights Report ACE-2101-801, pp.8, 42.

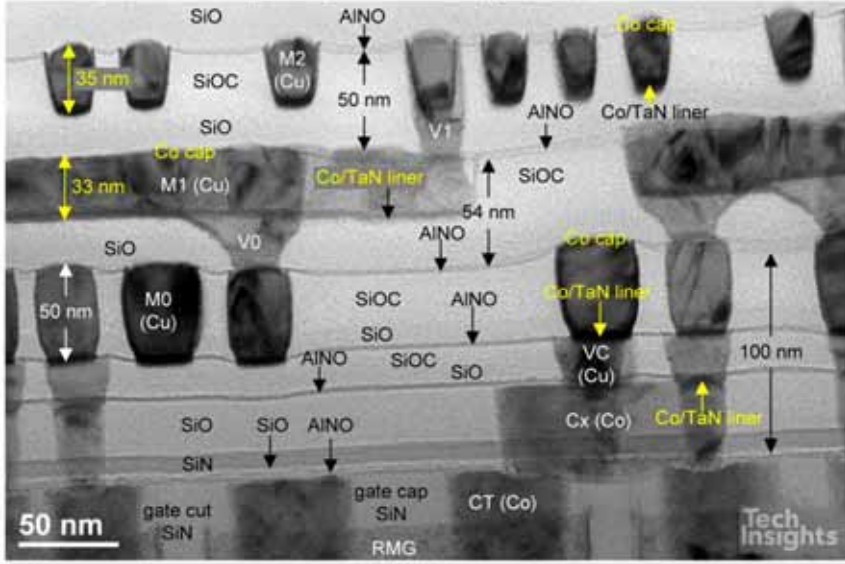
#	Claim Language	Accused Instrumentalities
18.1	18. A computing device, comprising:	To the extent the preamble of Claim 18 is limiting, each of the '183 Patent Accused Products, including for example the Galaxy S8, Galaxy S20, and Galaxy S21 mobile telephones, is a computing device.
18.2	a board;	Each of the '183 Patent Accused Products comprises a board that is coupled to a microprocessor.
18.3	and a component coupled to the board, the component including an integrated circuit structure, comprising:	Each of the '183 Patent Accused Products comprises a microprocessor component coupled to the board, such as for example the Snapdragon 835 – 10nm microprocessor, and for which the microprocessor component includes an integrated circuit structure.
18.4	a dielectric layer having an upper surface, the dielectric layer comprising silicon, oxygen and carbon;	Each of the '183 Patent Accused Products comprises a dielectric layer having an upper surface, the dielectric layer comprising silicon, oxygen and carbon. For example, the Snapdragon 835 – Samsung 10nm microprocessor includes a layer, shown as ILD 3-1 in the figure below, comprises silicon, oxygen and carbon as SiOC.¹⁹⁶ 

¹⁹⁶ TechInsights Report ACE-1704-802, p.20.

Also for example, the Samsung Exynos 990 – 7 nm microprocessor includes layers, each of which comprises silicon, oxygen, and carbon as SiOC:¹⁹⁷

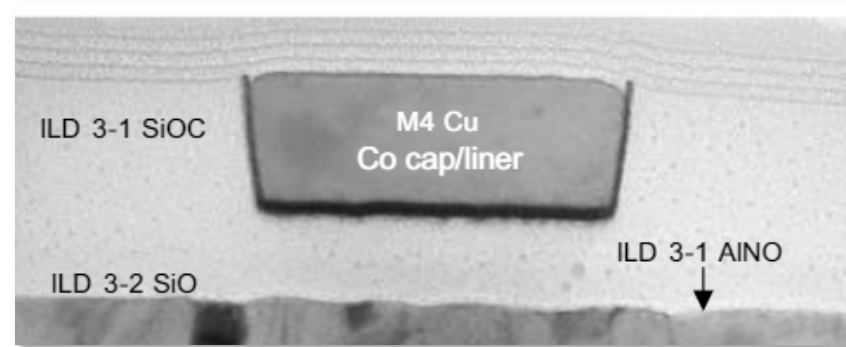


¹⁹⁷ TechInsights Report ACE-2003-801, p.44.

#	Claim Language	Accused Instrumentalities
		Also for example, the Snapdragon 888 - 5 nm processor comprises interlayer dielectric layers over the substrate, comprising silicon, oxygen, and carbon, shown as SiOC in the figure below.  198
18.5	a conductive structure in the dielectric layer, the conductive structure comprising:	Each of the '183 Patent Accused Products comprises a conductive structure in the dielectric layer.

¹⁹⁸ TechInsights Report ACE-2101-801, p.46.

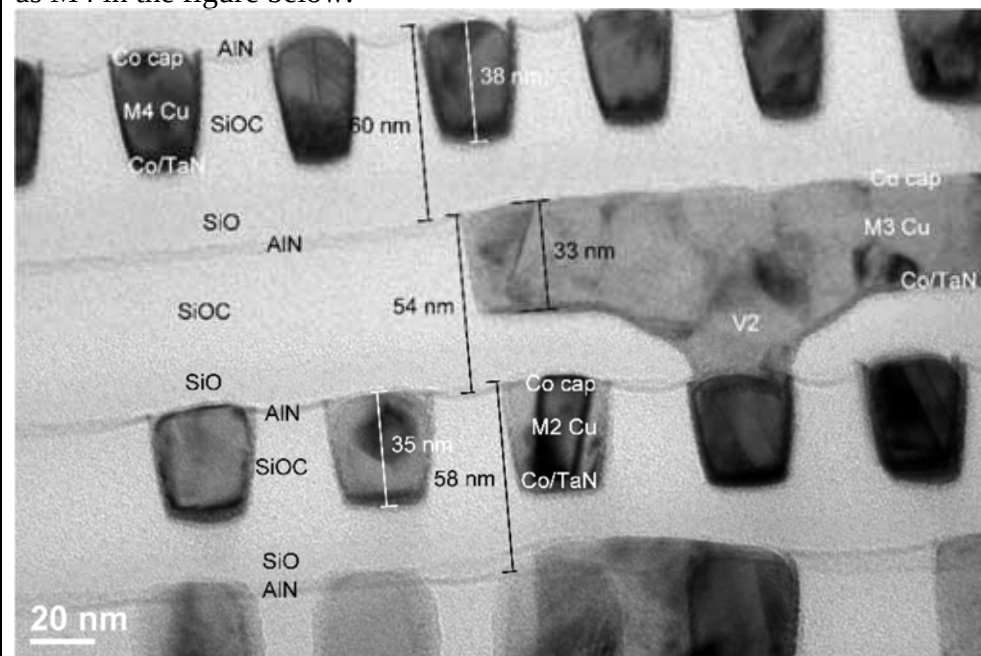
For example, the Snapdragon 835 – 10nm microprocessor comprises a conductive structure in the dielectric layer, the conductive structure comprising copper and cobalt, labeled as M4 in the figure below.¹⁹⁹



Also for example, the Samsung Exynos 990 - 7 nm microprocessor comprises a conductive structure in the dielectric layer, the conductive structure comprising copper and cobalt, labeled

¹⁹⁹ TechInsights Report ACE-1704-802, p.20.

as M4 in the figure below:²⁰⁰

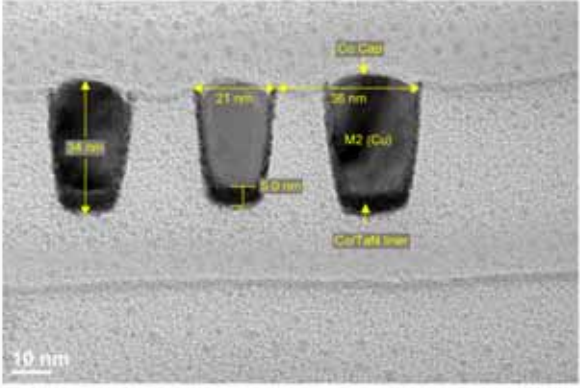


Also for example, the Snapdragon 888 - 5 nm processor comprises a conductive structure in the dielectric layer, the conductive structure comprising copper and cobalt,²⁰¹ as shown for M2 in the figure below:²⁰²

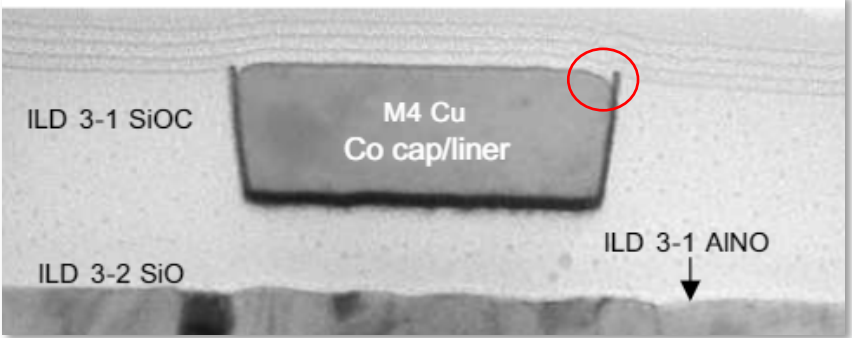
²⁰⁰ TechInsights Report ACE-2003-801, p.42.

²⁰¹ TechInsights Report ACE-2003-801, p.8.

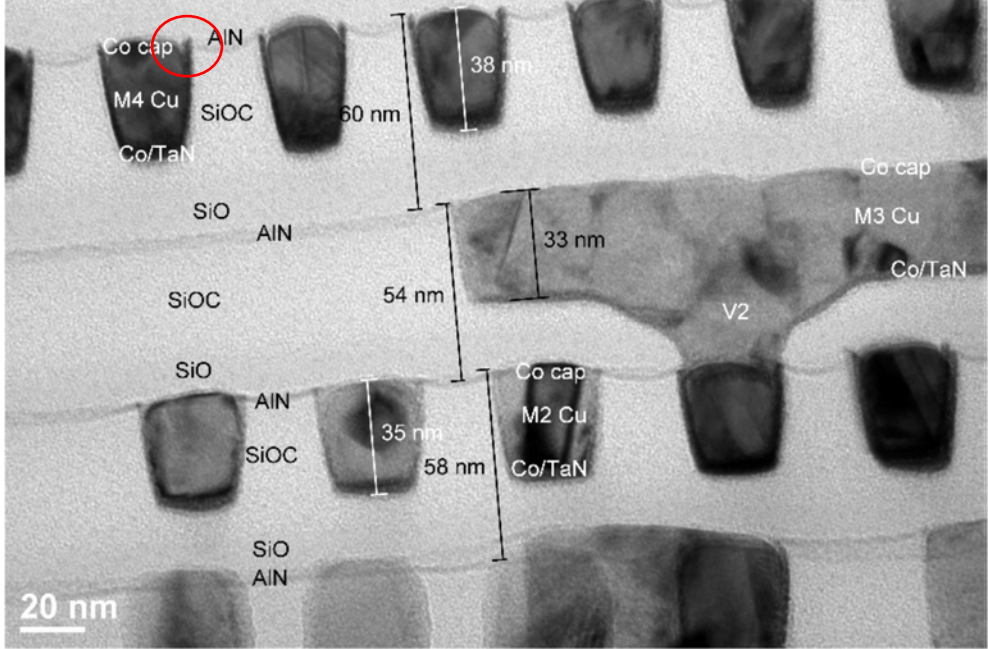
²⁰² TechInsights Report ACE-2101-801, p.42.

#	Claim Language	Accused Instrumentalities
		 M2 180k b_379858.png
18.6	a first conductive material comprising copper, the first conductive material having an upper surface, with a portion of the upper surface of the first conductive material below a portion of the upper surface of the dielectric layer; and	In each of the '183 Patent Accused Products, the conductive structure comprises a first conductive material comprising copper, the first conductive material having an upper surface, with a portion of the upper surface of the first conductive material below a portion of the upper surface of the dielectric layer. For example, the Snapdragon 835 – 10nm microprocessor comprises a conductive structure in the dielectric layer, the conductive structure further comprising a first conductive material comprising copper, the first conductive material having an upper surface, with a portion of the upper surface of the first conductive material below a portion of the upper surface of the dielectric layer. On information and belief, a portion of the conductive material comprising copper forms a divot that falls a distance below the upper surface of the dielectric layer (circled in red).²⁰³

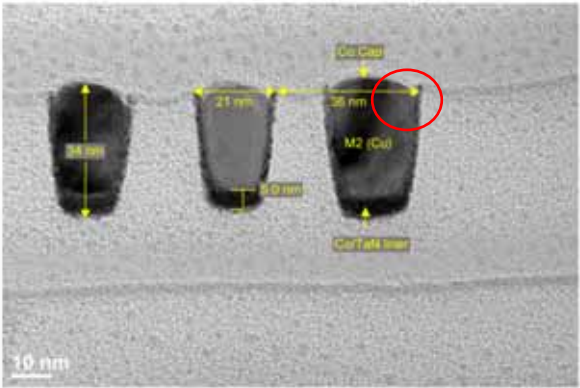
²⁰³ TechInsights Report ACE-1704-802, p.20.

#	Claim Language	Accused Instrumentalities
		 Also for example, the Samsung Exynos 990 - 7 nm microprocessor comprises a conductive structure in the dielectric layer, the conductive structure further comprising a first conductive material comprising copper, the first conductive material having an upper surface, with a portion of the upper surface of the first conductive material below a portion of the upper surface of the dielectric layer. On information and belief, a portion of the conductive material comprising copper forms a divot that falls a distance below the upper surface of the dielectric layer (circled in red):²⁰⁴

²⁰⁴ TechInsights Report ACE-2003-801, p.44.

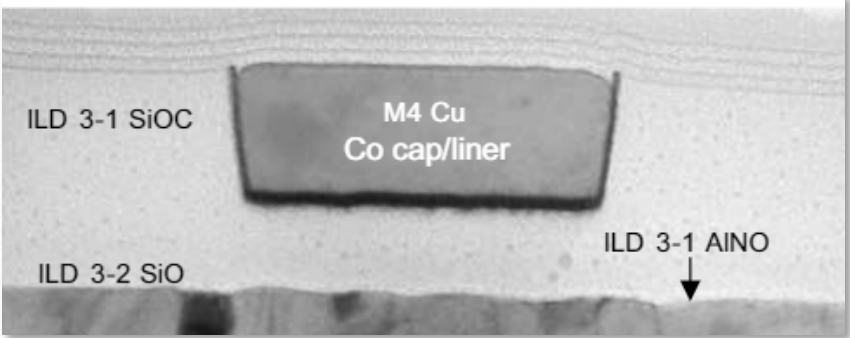
#	Claim Language	Accused Instrumentalities
		 Also for example, the Snapdragon 888 - 5 nm processor comprises a conductive structure in the dielectric layer, the conductive structure further comprising a first conductive material comprising copper, the first conductive material having an upper surface, with a portion of the upper surface of the first conductive material below a portion of the upper surface of the dielectric layer.²⁰⁵ On information and belief, a portion of the conductive material comprising

²⁰⁵ TechInsights Report ACE-2101-801, pp.8, 42.

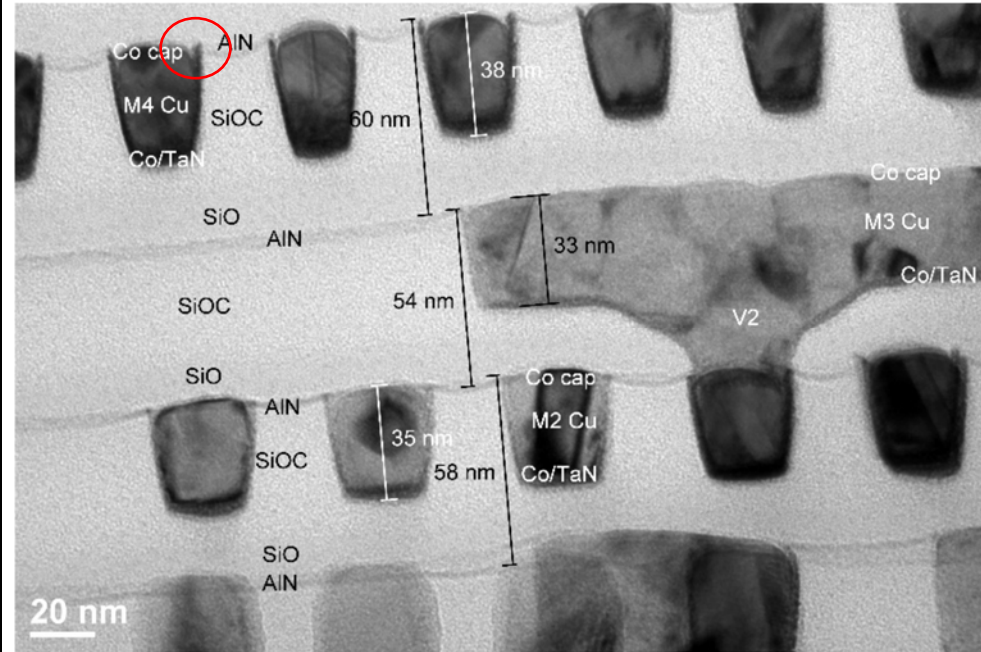
#	Claim Language	Accused Instrumentalities
		copper forms a divot that falls a distance below the upper surface of the dielectric layer (circled in red), as shown for M2 in the figure below:²⁰⁶  M2 180k b_379858.png
18.7	a second conductive material on the upper surface of the first conductive material, the second conductive material comprising cobalt, wherein the first conductive material and the second conductive material have a same width at a location where the first conductive material and the second conductive material meet, wherein the second conductive material has an	In each of the '183 Patent Accused Products, the conductive structure comprises a second conductive material on the upper surface of the first conductive material, the second conductive material comprising cobalt, wherein the first conductive material and the second conductive material have a same width at a location where the first conductive material and the second conductive material meet, wherein the second conductive material has an upper surface having a portion substantially co-planar with the portion of the upper surface of the dielectric layer, and wherein the upper surface of the second conductive material has a curved corner below the portion of the upper surface of the dielectric layer. For example, in the Snapdragon 835 – 10nm microprocessor the second conductive material is a cobalt capping layer on top of the copper conductive material. The divot forms a curved corner.²⁰⁷

²⁰⁶ TechInsights Report ACE-2101-801, p.42.

²⁰⁷ TechInsights Report ACE-1704-802, p.20.

#	Claim Language	Accused Instrumentalities
	upper surface having a portion substantially co-planar with the portion of the upper surface of the dielectric layer, and wherein the upper surface of the second conductive material has a curved corner below the portion of the upper surface of the dielectric layer; and	 ILD 3-1 SiOC M4 Cu Co cap/liner ILD 3-2 SiO ILD 3-1 AlNO

Also for example, in the Samsung Exynos 990 - 7 nm microprocessor, the second conductive material is a cobalt capping layer on top of the copper conductive material. The divot forms a curved corner:²⁰⁸

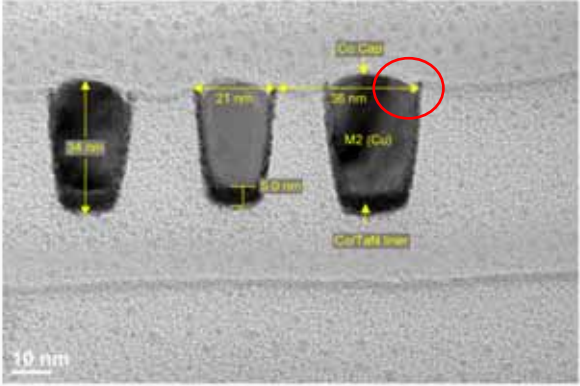


Also for example, in the Snapdragon 888 - 5 nm processor, the second conductive material is a cobalt capping layer on top of the copper conductive material.²⁰⁹ The divot forms a curved corner.²¹⁰

²⁰⁸ TechInsights Report ACE-2003-801, p.44.

²⁰⁹ TechInsights Report ACE-2101-801, p.8.

²¹⁰ TechInsights Report ACE-2101-801, p.42.

#	Claim Language	Accused Instrumentalities
		 M2 180k b_379858.png
18.8	a barrier layer partially surrounding the conductive structure, the barrier layer comprising tantalum.	Each of the '183 Patent Accused Products comprises a barrier layer partially surrounding the conductive structure, the barrier layer comprising tantalum. For example, the barrier layer in the Snapdragon 835 – Samsung 10nm microprocessor is Tantalum-based. Also for example, the barrier layer in the Samsung Exynos – 7 nm microprocessor is Tantalum-based.²¹¹ Also for example, the barrier layer in the Snapdragon 888 - 5 nm processor is Tantalum-based.²¹²
19.1	19. The computing device of claim 18, further comprising:	See claim 18, above.

²¹¹ TechInsights Report ACE-2003-801, pp.8, 40.

²¹² TechInsights Report ACE-2101-801, pp.8, 42.

#	Claim Language	Accused Instrumentalities
19.2	a memory coupled to the board.	Each of the '183 Patent Accused Products comprises a memory, such as RAM, ROM, and/or flash memory, coupled to the board. For example, the Samsung Galaxy S21 has 8 GB of LPDDR5 memory and 128 or 256 GB of storage memory. ²¹³
20.1	20. The computing device of claim 18, further comprising:	See claim 18, above.
20.2	a communication chip coupled to the board.	Each of the '183 Patent Accused Products comprises a communication chip, such as a chip to enable Wi-Fi, bluetooth, and/or cellular radio communications, coupled to the board. For example, the Snapdragon 888 processor in the Samsung Galaxy S21 has an integrated 5G modem, and the Samsung Galaxy S21 also has chips that enable Wi-Fi and Bluetooth communications. ²¹⁴
21.1	21. The computing device of claim 18, further comprising:	See claim 18, above.
21.2	a camera coupled to the board.	Each of the '183 Patent Accused Products (except for the Samsung Galaxy Watch4, Samsung Galaxy Watch4 Classic, Samsung Galaxy Watch3, Samsung Galaxy Watch Active2, and Samsung Galaxy Watch Active) comprises a camera, such as a lens and photosensor, coupled to the board.

²¹³ https://www.ifixit.com/Device/Samsung_Galaxy_S21#Section_Background_and_Identification .

²¹⁴ https://www.ifixit.com/Device/Samsung_Galaxy_S21#Section_Background_and_Identification .

#	Claim Language	Accused Instrumentalities
		For example, the Samsung Galaxy S21 has main and selfie cameras coupled to the board. ²¹⁵
22.1	22. The computing device of claim 18, further comprising:	See claim 18, above.
22.2	a battery coupled to the board.	Each of the '183 Patent Accused Products comprises a battery, such as a lithium-ion battery, coupled to the board. For example, the Samsung Galaxy S21 has a Li-Ion 4000 mAh, non-removable battery coupled to the board. ²¹⁶
23.1	23. The computing device of claim 18, further comprising:	See claim 18, above.
23.2	an antenna coupled to the board.	Each of the '183 Patent Accused Products comprises an antenna, such as Wi-Fi, Bluetooth, and/or cellular radio antenna, coupled to the board. For example, the Samsung Galaxy S21 has a 5G antenna coupled to the board. ²¹⁷
24.1	24. The computing device of claim 18,	See claim 18, above.

²¹⁵ https://www.ifixit.com/Device/Samsung_Galaxy_S21#Section_Background_and_Identification .

²¹⁶ https://www.ifixit.com/Device/Samsung_Galaxy_S21#Section_Background_and_Identification .

²¹⁷ <https://www.ifixit.com/Guide/Samsung+Galaxy+S21+5G+Antenna+Replacement/148692>

#	Claim Language	Accused Instrumentalities
24.2	wherein the component is a packaged integrated circuit die.	The semiconductor processor in each of the '183 Patent Accused Products is a packaged integrated circuit die. For example, the Snapdragon 888 in the Samsung Galaxy S21 is a packed integrated circuit die. ²¹⁸
25.1	25. The computing device of claim 18,	See claim 18, above.
25.2	wherein the component is selected from the group consisting of a processor, a communications chip, and a digital signal processor.	The semiconductor processor in each of the '183 Patent Accused Products is a processor. For example, the Snapdragon 888 in the Samsung Galaxy S21 is a processor. ²¹⁹

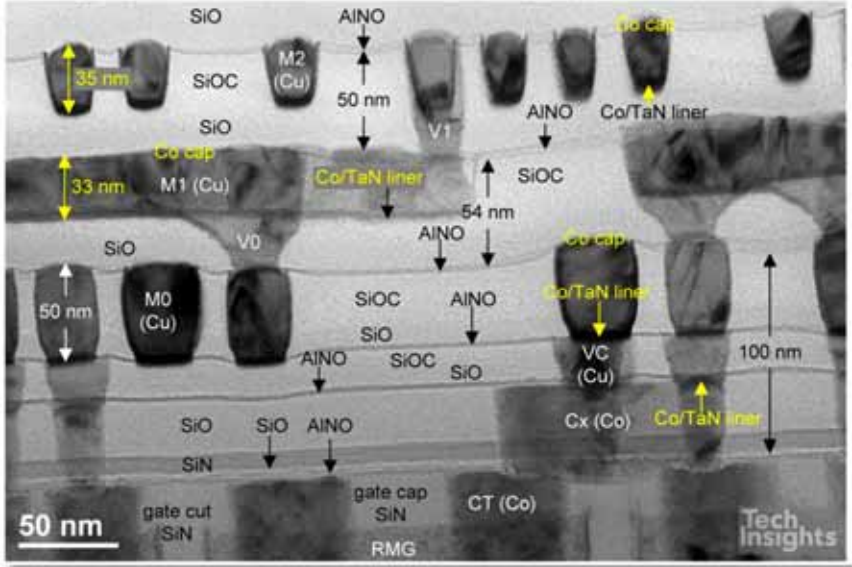
²¹⁸ TechInsights Report ACE-2101-801, pp. 5, 9-14.

²¹⁹ TechInsights Report ACE-2101-801.

EXHIBIT D
(INFRINGEMENT OF U.S PATENT NO. 9,672,321)

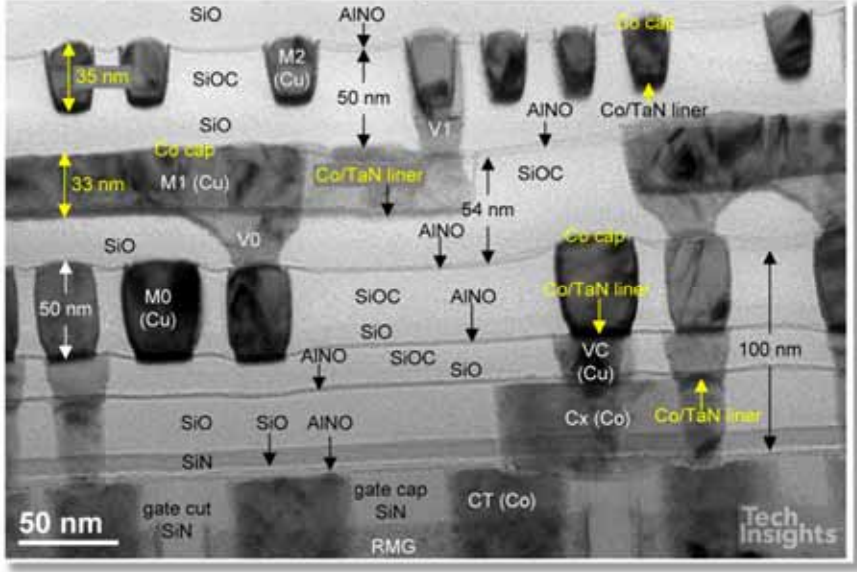
#	Claim Language	Accused Instrumentalities
1.1	1. An apparatus, comprising:	To the extent the preamble of Claim 1 is limiting, each of the '321 Patent Accused Products comprises an apparatus. For example, the Snapdragon 888 - 5 nm processor comprises an apparatus.
1.2	a substrate comprising silicon;	Each of the '321 Patent Accused Products comprises a substrate comprising silicon. For example, the Snapdragon 888 - 5 nm processor comprises a substrate comprising silicon.
1.3	an interlayer dielectric layer over the substrate, the interlayer dielectric layer comprising silicon, oxygen, and carbon, the interlayer dielectric layer having a top boundary;	Each of the '321 Patent Accused Products comprises an interlayer dielectric layer over the substrate, the interlayer dielectric layer comprising silicon, oxygen, and carbon, the interlayer dielectric layer having a top boundary. For example, the Snapdragon 888 - 5 nm processor comprises interlayer dielectric layers over the substrate, comprising silicon, oxygen, and carbon, shown as SiOC in the figure below. ²²⁰ Each interlayer dielectric layer has a top boundary:

²²⁰ TechInsights Report ACE-2101-801, p.46.

#	Claim Language	Accused Instrumentalities
1.4	a trench in the interlayer dielectric layer, the trench having internal sidewalls;	Each of the '321 Patent Accused Products comprises a trench in the interlayer dielectric layer, the trench having internal sidewalls. For example, the Snapdragon 888 - 5 nm processor comprises M0-M4 copper metal layers, each comprising at least one trench in a corresponding SiOC interlayer dielectric layer,²²¹ as shown for M0-M2 in the figure below:²²² 
1.5	a barrier layer comprising tantalum and nitrogen on the internal sidewalls of the trench;	Each of the '321 Patent Accused Products comprises a barrier layer comprising tantalum and nitrogen on the internal sidewalls of the trench.

²²¹ TechInsights Report ACE-2101-801, p.8.

²²² TechInsights Report ACE-2101-801, p.46.

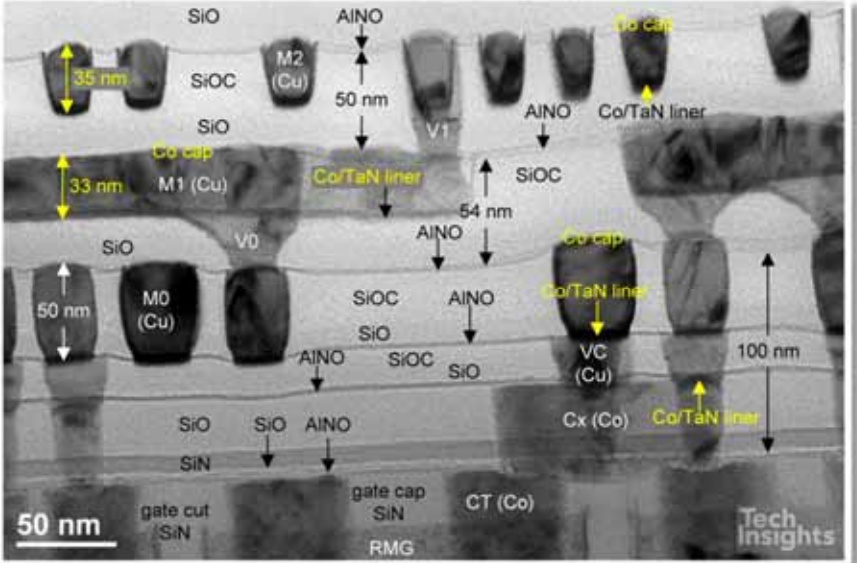
#	Claim Language	Accused Instrumentalities
		For example, the Snapdragon 888 - 5 nm processor comprises M0-M4 copper metal layers further comprising liners on the internal sidewalls of the trenches comprising cobalt, tantalum and nitrogen,²²³ as shown for M0-M2 in the figure below:²²⁴ 
1.6	a conductive material in the trench, the barrier layer between the conductive material and the interlayer dielectric layer; and	Each of the '321 Patent Accused Products comprises a conductive material in the trench, the barrier layer between the conductive material and the interlayer dielectric layer. For example, the Snapdragon 888 - 5 nm processor comprises M0-M4 copper metal layers comprising conductive copper and cobalt in the trenches,²²⁵ as shown for M0-M2 in the figure below:²²⁶

²²³ TechInsights Report ACE-2101-801, p.8.

²²⁴ TechInsights Report ACE-2101-801, p.46.

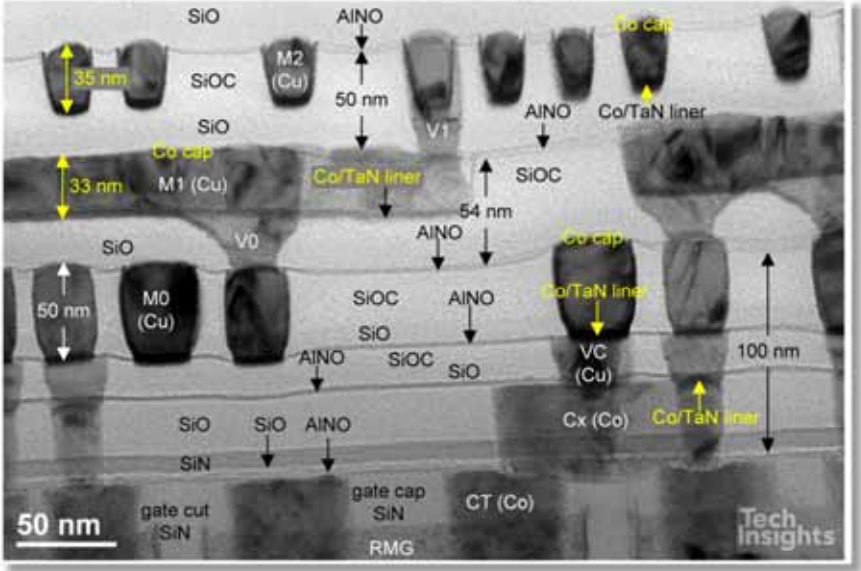
²²⁵ TechInsights Report ACE-2101-801, p.8.

²²⁶ TechInsights Report ACE-2101-801, p.46.

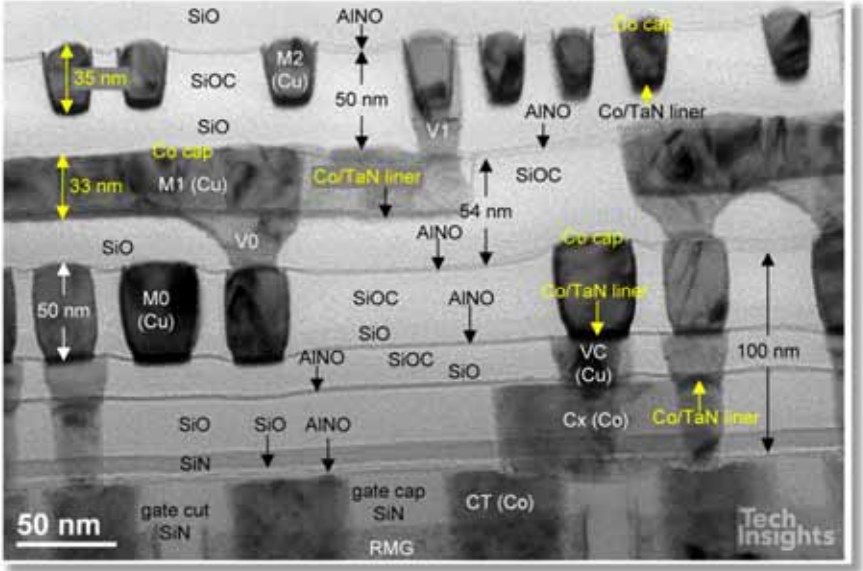
#	Claim Language	Accused Instrumentalities
		
1.7	a capping region comprising cobalt directly on the top of the conductive material comprising copper and cobalt, a top of the capping region near the interlayer dielectric layer being no higher than the top boundary of the interlayer	Each of the '321 Patent Accused Products comprises a capping region comprising cobalt directly on the top of the conductive material comprising copper and cobalt, a top of the capping region near the interlayer dielectric layer being no higher than the top boundary of the interlayer dielectric layer that is near the capping region. For example, the Snapdragon 888 - 5 nm processor comprises M0-M4 copper metal layers comprising a cobalt cap directly on top of the conductive material comprising copper and cobalt²²⁷ as shown for M0-M2 in the figure below.²²⁸

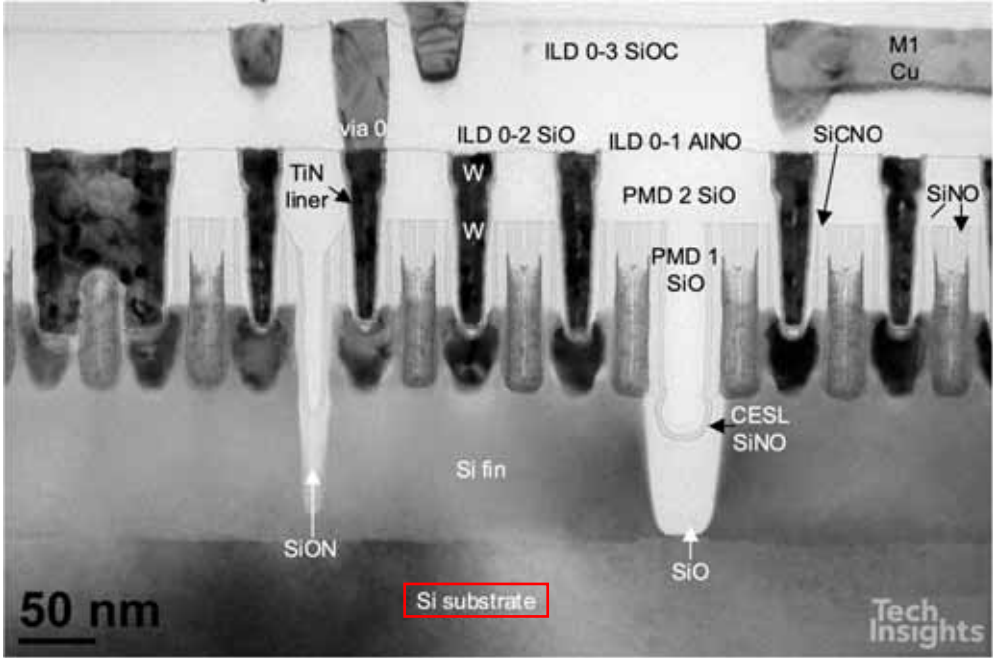
²²⁷ TechInsights Report ACE-2101-801, p.8.

²²⁸ TechInsights Report ACE-2101-801, p.46.

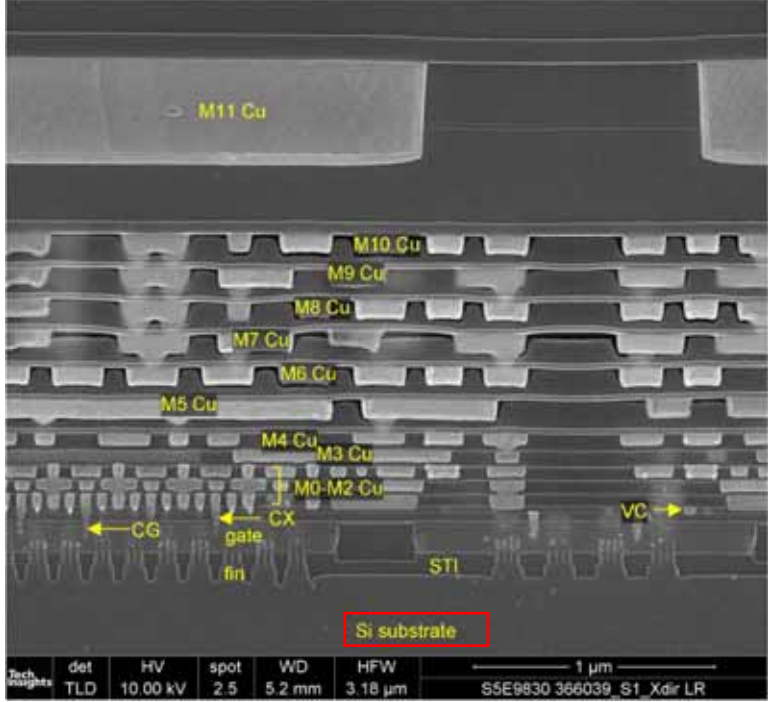
#	Claim Language	Accused Instrumentalities
	dielectric layer that is near the capping region.	 For example, in at least the Snapdragon 888 - 5 nm processor M0-M2 copper metal layers, the cobalt cap near the interlayer dielectric layer is no higher than the top boundary of the interlayer dielectric layer near the cobalt cap as shown in the figure below.²²⁹

²²⁹ TechInsights Report ACE-2101-801, p.46.

#	Claim Language	Accused Instrumentalities
		
2.1	2. The apparatus of claim 1,	See claim 1, above.
2.2	wherein the interlayer dielectric layer comprises a low-k material.	Each of the '321 Patent Accused Products comprises an interlayer dielectric layer that comprises a low-k dielectric material. For example, SiOC is a low-k dielectric material.
7.1	7. An apparatus, comprising:	Each of the '321 Patent Accused Products comprises an apparatus. For example, the Samsung Galaxy S21 phone which includes the Snapdragon 888 - 5 nm processor, the Samsung Galaxy S20 phone which includes the Samsung Exynos 990 - 7 nm processor and the Samsung Galaxy S8 phone which includes the Snapdragon 835 - 10 nm processor each comprise an apparatus.

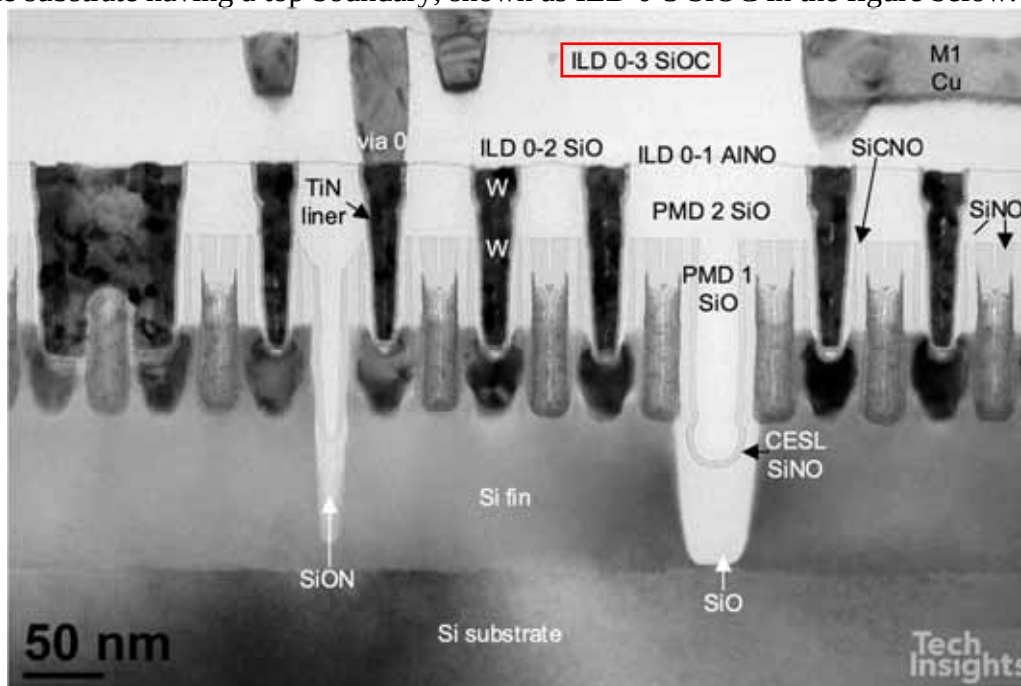
#	Claim Language	Accused Instrumentalities
7.2	a substrate comprising a semiconductor material;	Each of the '321 Patent Accused Products comprises a substrate comprising a semiconductor material. For example, the Snapdragon 835 - Samsung 10nm microprocessor comprises a silicon substrate as shown in the figure below:²³⁰ 

²³⁰ TechInsights Report ACE-1704-802, p.21.

#	Claim Language	Accused Instrumentalities
		Also for example, the Samsung Exynos 990 – 7 nm processor comprises a silicon substrate as shown in the figure below:²³¹  The image is a cross-sectional scanning electron micrograph (SEM) of a semiconductor device. It shows a stack of metal layers labeled M0-M2-Cu, M3-Cu, M4-Cu, M5-Cu, M6-Cu, M7-Cu, M8-Cu, M9-Cu, M10-Cu, and M11-Cu. Below the metal layers are gate structures, fins, and shallow trench isolations (STI). The bottom layer is the Si substrate, which is highlighted with a red box. Technical data at the bottom includes: Tech: TLD, det: TLD, HV: 10.00 kV, spot: 2.5, WD: 5.2 mm, HFW: 3.18 μm, and a scale bar of 1 μm.
7.3	a dielectric layer over the substrate, the dielectric layer having a top boundary;	Each of the '321 Patent Accused Products comprises a dielectric layer over the substrate, the dielectric layer having a top boundary.

²³¹ TechInsights Report ACE-2003-801, p.41.

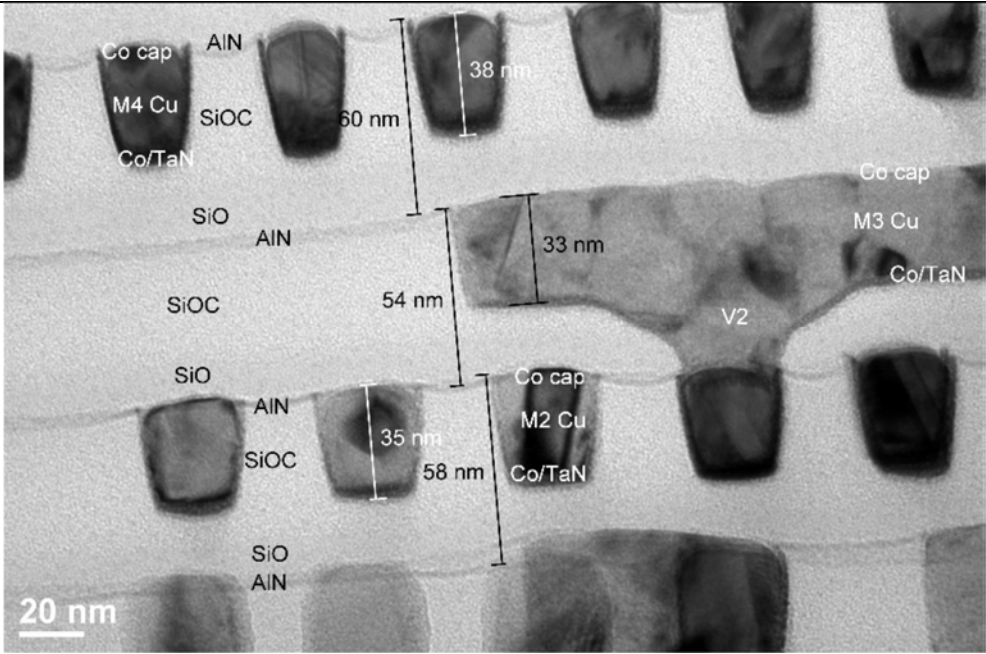
For example, the Snapdragon 835 – Samsung 10nm microprocessor includes a dielectric layer over the substrate having a top boundary, shown as ILD 0-3 SiOC in the figure below:²³²



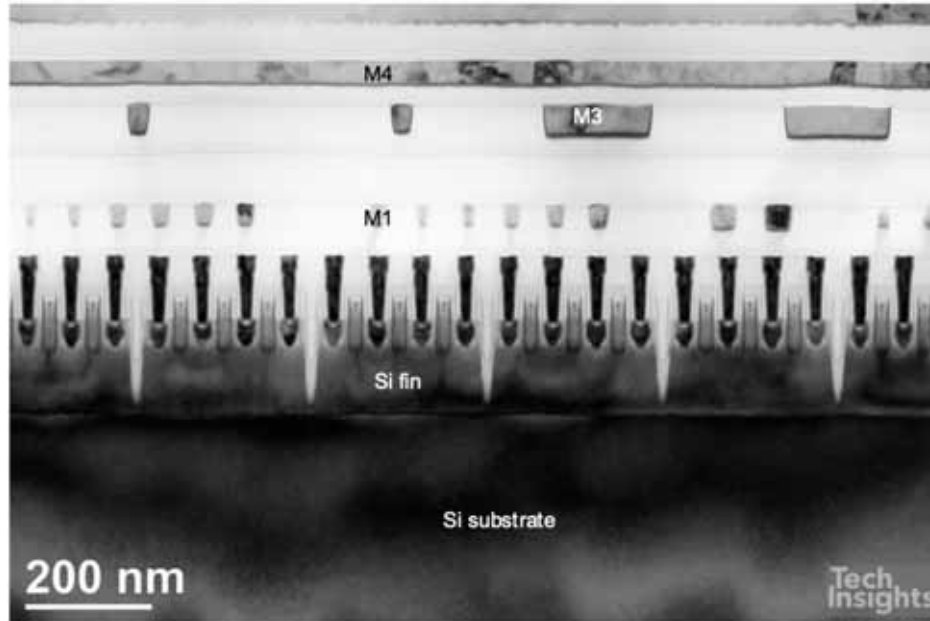
For example, the Samsung Exynos 990 – 7 nm microprocessor includes an SiOC dielectric layer over the substrate having a top boundary:²³³

²³² TechInsights Report ACE-1704-802, p.21.

²³³ TechInsights Report ACE-2003-801, p.44.

#	Claim Language	Accused Instrumentalities
		
7.4	a plurality of trenches in the dielectric layer, the plurality of trenches having sidewalls;	Each of the '321 Patent Accused Products comprises a plurality of trenches in the dielectric layer, the plurality of trenches having sidewalls.

For example, the Snapdragon 835 – Samsung 10nm microprocessor includes an M1 metal layer that comprises a plurality of trenches in the ILD 0-3 dielectric layer as shown in the figure below:²³⁴



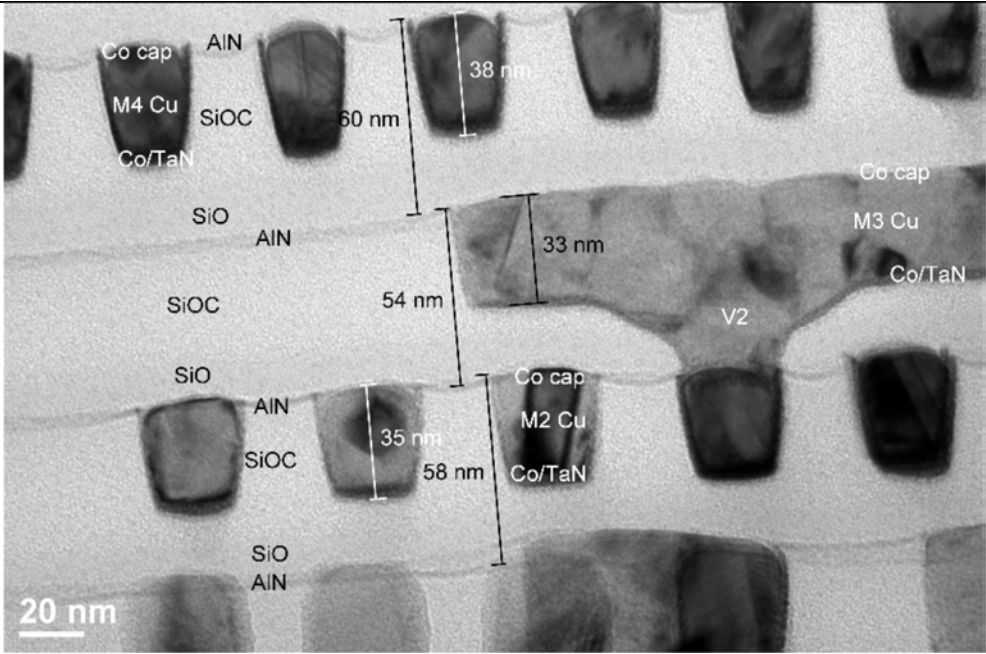
The M1 trenches have sidewalls as shown in the figure below:²³⁵

²³⁴ TechInsights Report ACE-1704-802, p.26.

²³⁵ TechInsights Report ACE-1704-802, p.22.

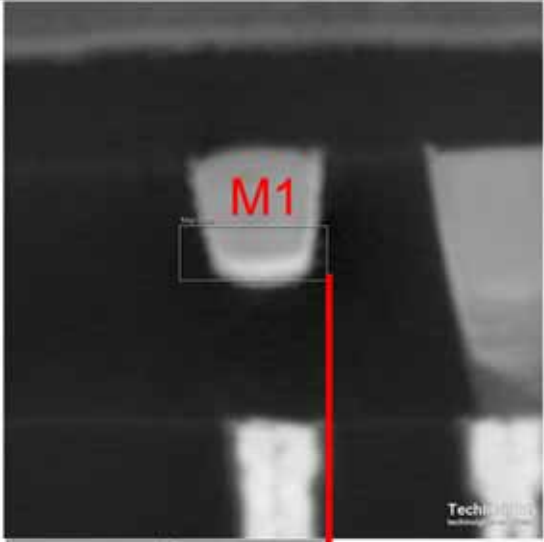
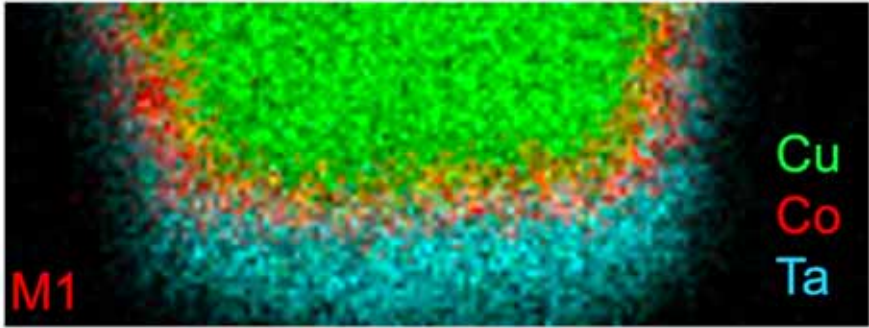
#	Claim Language	Accused Instrumentalities
		The image is a grayscale micrograph of a semiconductor device. A bright, irregularly shaped region in the center is labeled 'M1' in red. A small white box is drawn around the bottom-left corner of the 'M1' label. A prominent red vertical line extends downwards from the bottom of this white box. The background is dark with some lighter, blurry regions. In the bottom right corner, there is a small logo that reads 'TechInsights'. Also for example, the Samsung Exynos 990 - 7 nm microprocessor includes an M2 metal layer that comprises a plurality of trenches in the SiOC dielectric layer as shown in the figure below:²³⁶

²³⁶ TechInsights Report ACE-2003-801, p.44.

#	Claim Language	Accused Instrumentalities
		
7.5	a barrier layer on the sidewalls of at least some of the plurality of trenches;	Each of the '321 Patent Accused Products comprises a barrier layer on the sidewalls of at least some of the plurality of trenches. For example, in the Snapdragon 835 – Samsung 10nm microprocessor at least some of the copper M1-M4 metal layer trenches have a tantalum barrier layer on the sidewalls,²³⁷ as shown in the figure for M1 below:²³⁸

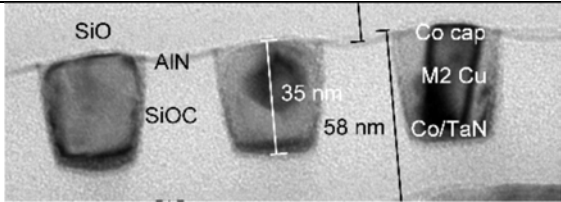
²³⁷ TechInsights Report ACE-1704-802, p.5.

²³⁸ TechInsights Report ACE-1704-802, p.22.

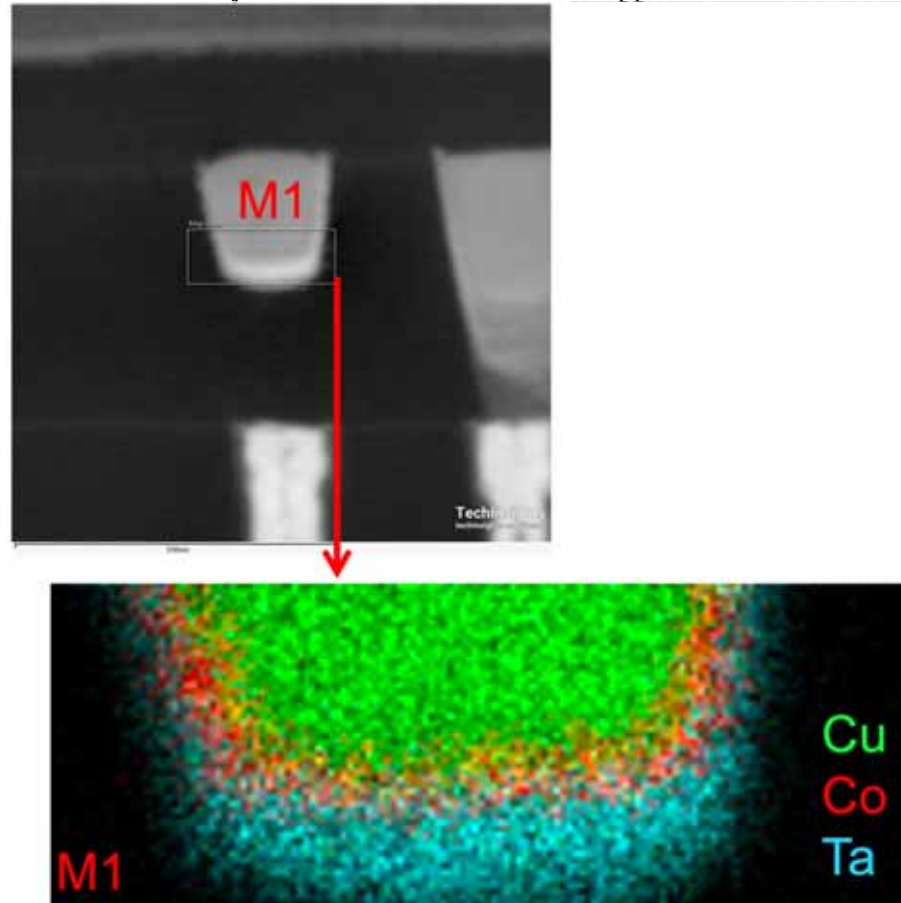
#	Claim Language	Accused Instrumentalities
		  Also example, in the Samsung Exynos 990 – 7 nm microprocessor at least some of the copper M0-M4 metal layer trenches have a tantalum barrier layer on the sidewalls,²³⁹ as shown in the figure for M2 below:²⁴⁰

²³⁹ TechInsights Report ACE-2003-801, p.8.

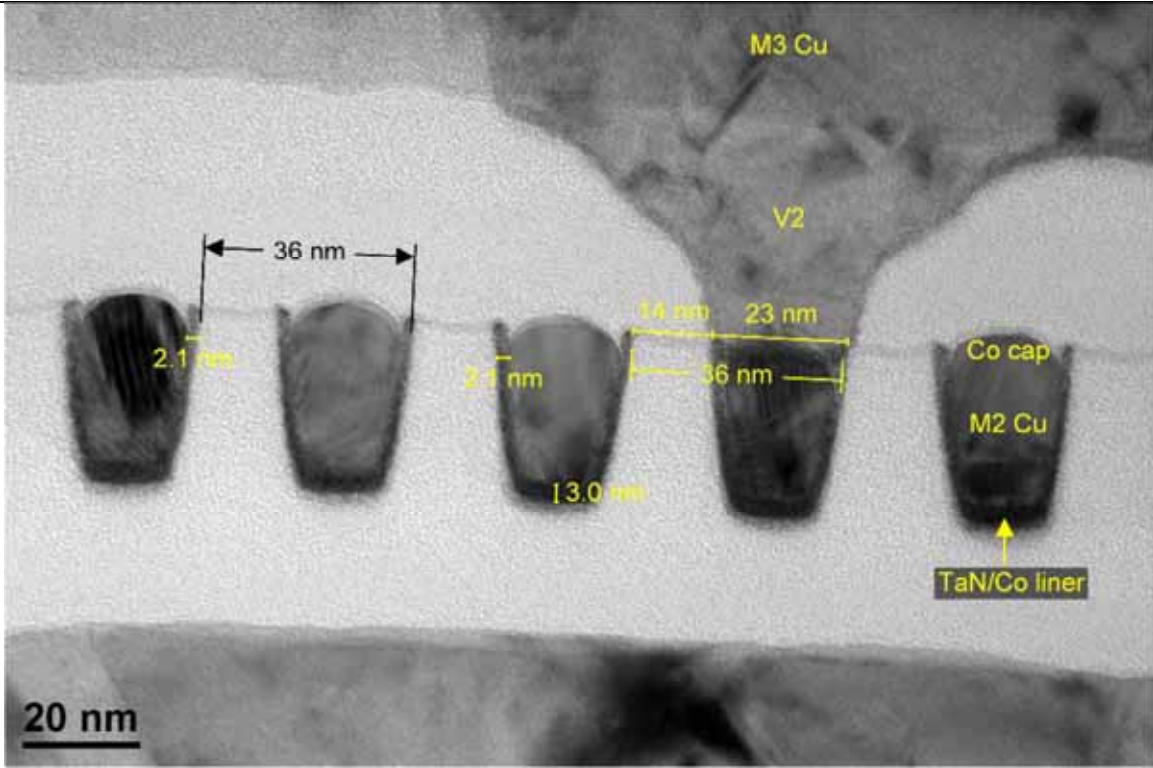
²⁴⁰ TechInsights Report ACE-2003-801, p.44.

#	Claim Language	Accused Instrumentalities
		
7.6	conductive material in the at least some of the plurality of trenches, the barrier layer being between the conductive material and the sidewalls, the conductive material being no higher than the top boundary of the dielectric layer at a location near to the conductive material; and	Each of the '321 Patent Accused Products comprises conductive material in the at least some of the plurality of trenches, the barrier layer being between the conductive material and the sidewalls, the conductive material being no higher than the top boundary of the dielectric layer at a location near to the conductive material. For example, the Snapdragon 835 – Samsung 10nm microprocessor comprises conductive copper and cobalt in the M1 metal layer trenches, with a tantalum barrier between the copper

and the sidewalls and the conductive copper and cobalt being no higher than the top boundary of the ILD 0-3 dielectric layer at a location near to the copper, as shown in the figure below:²⁴¹



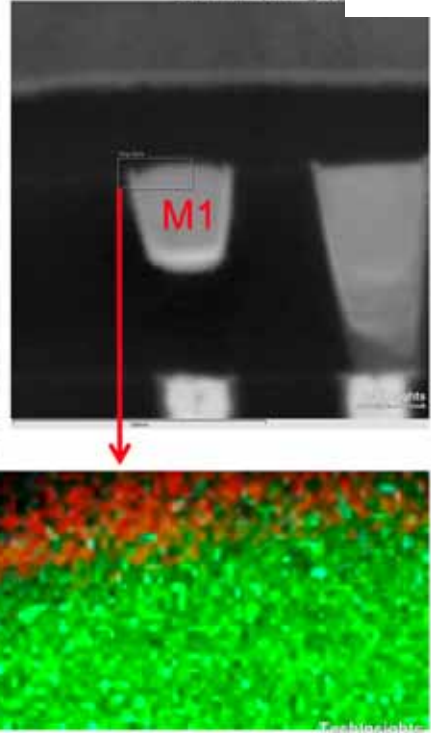
Also for example, the Samsung Exynos 990 – 7 nm microprocessor comprises conductive copper and cobalt in the M2 metal layer trenches, with a tantalum barrier between the copper and the sidewalls and the conductive copper and cobalt being no higher than the top boundary of the dielectric layer at a location near to the copper, as shown in the figure below:²⁴²

#	Claim Language	Accused Instrumentalities
		
7.7	a capping region comprising cobalt directly on the conductive material comprising copper and cobalt, the capping region being no higher than the	Each of the '321 Patent Accused Products comprises a capping region comprising cobalt directly on the conductive material comprising copper and cobalt, the capping region being no higher than the top boundary of the dielectric layer that is near to the capping region. For example, the Snapdragon 835 – Samsung 10nm microprocessor comprises copper metal layers 1-4 having a cobalt capping layer.²⁴³ As shown for M1 in the figure below, the coSbalt

²⁴¹ TechInsights Report ACE-1704-802, p.22.

²⁴² TechInsights Report ACE-2003-801, pp.8, 40.

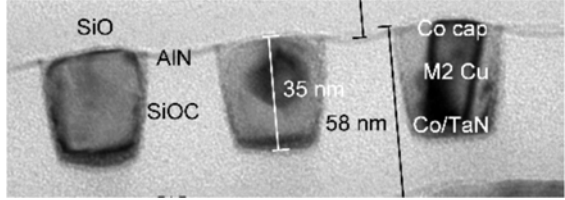
²⁴³ TechInsights Report ACE-1704-802, p.5.

#	Claim Language	Accused Instrumentalities
	top boundary of the dielectric layer that is near to the capping region.	cap is directly on the conductive material comprising copper and cobalt and is no higher than the top boundary of the dielectric layer that is near to the capping region:²⁴⁴ Metal 1 6 Materials Analysis – TE EELS/M1 Map Area_top  Also for example, the Samsung Exynos 990 – 7nm microprocessor comprises copper metal layers 0-4 having anor cobalt capping layer.²⁴⁵ As shown for M2 in the figure below, the cobalt cap is directly on the conductive material comprising copper and cobalt and is no higher than the top boundary of the dielectric layer that is near to the capping region:²⁴⁶

²⁴⁴ TechInsights Report ACE-1704-802, p.22.

²⁴⁵ TechInsights Report ACE-2003-801, p.8.

²⁴⁶ TechInsights Report ACE-2003-801, p.44.

#	Claim Language	Accused Instrumentalities
		
8.1	8. The apparatus of claim 7,	See claim 7, above.
8.2	wherein the dielectric layer comprises a silicon, oxygen, and carbon.	Each of the '321 Patent Accused Products comprises a dielectric layer that comprises a silicon, oxygen, and carbon. For example, SiOC is a silicon, oxygen, and carbon.
9.1	9. The apparatus of claim 8,	See claim 8, above.
9.2	wherein the dielectric layer comprises carbon doped silicon oxide.	Each of the '321 Patent Accused Products comprises a dielectric layer that comprises a silicon, oxygen, and carbon. For example, SiOC comprises carbon doped silicon oxide.