Electronics Materials Information

TECHCET Membership Advisory Quarterly Update

for

Sematech Critical Materials Council

by Techcet Group

a Techcet CA LLC Company

August 2015

www.Techcet.com
info@Techcet.com

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Section 1

QUARTERLY UPDATE - CMP Consumables

Sue Davis

August 2015

www.Techcet.com
info@Techcet.com

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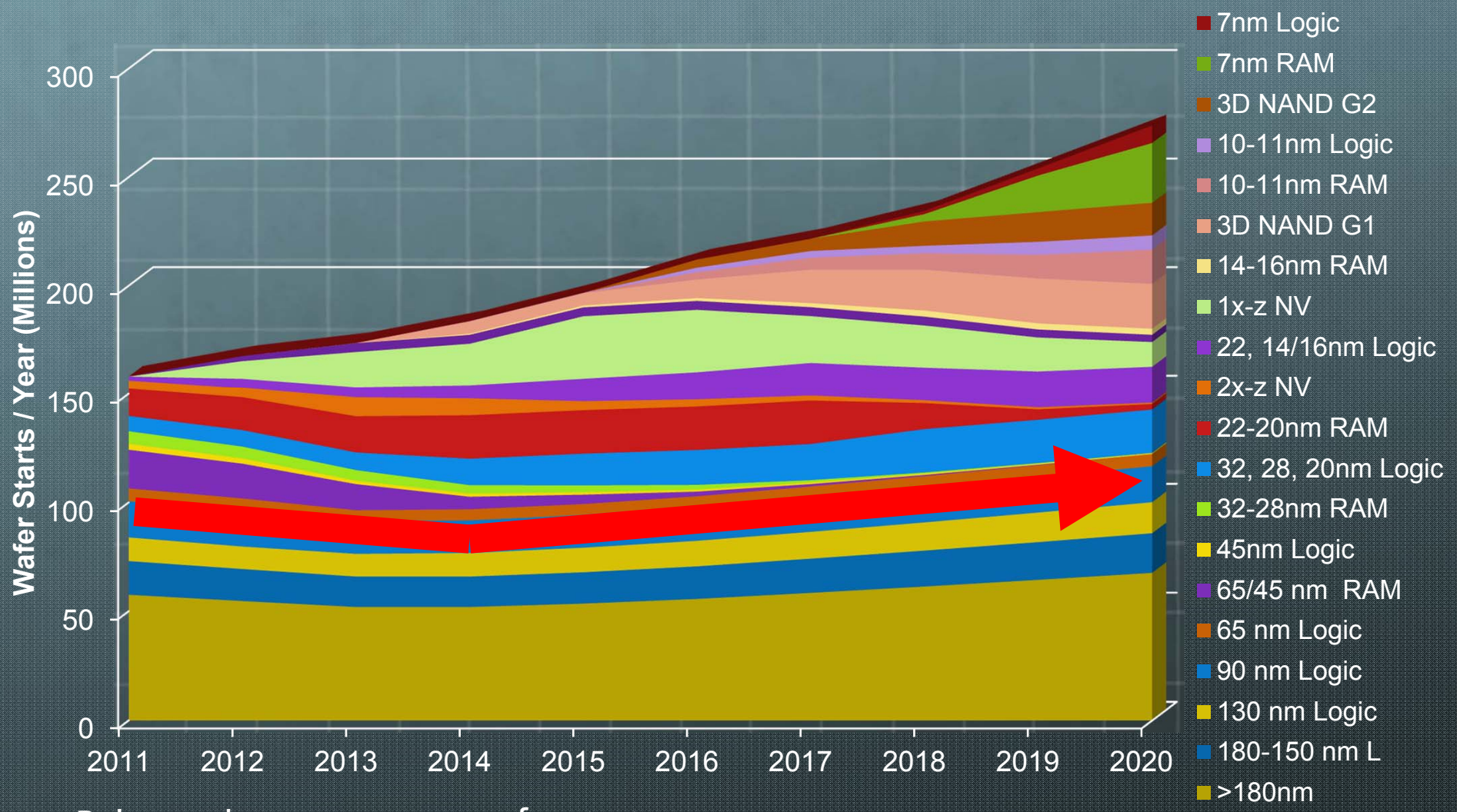
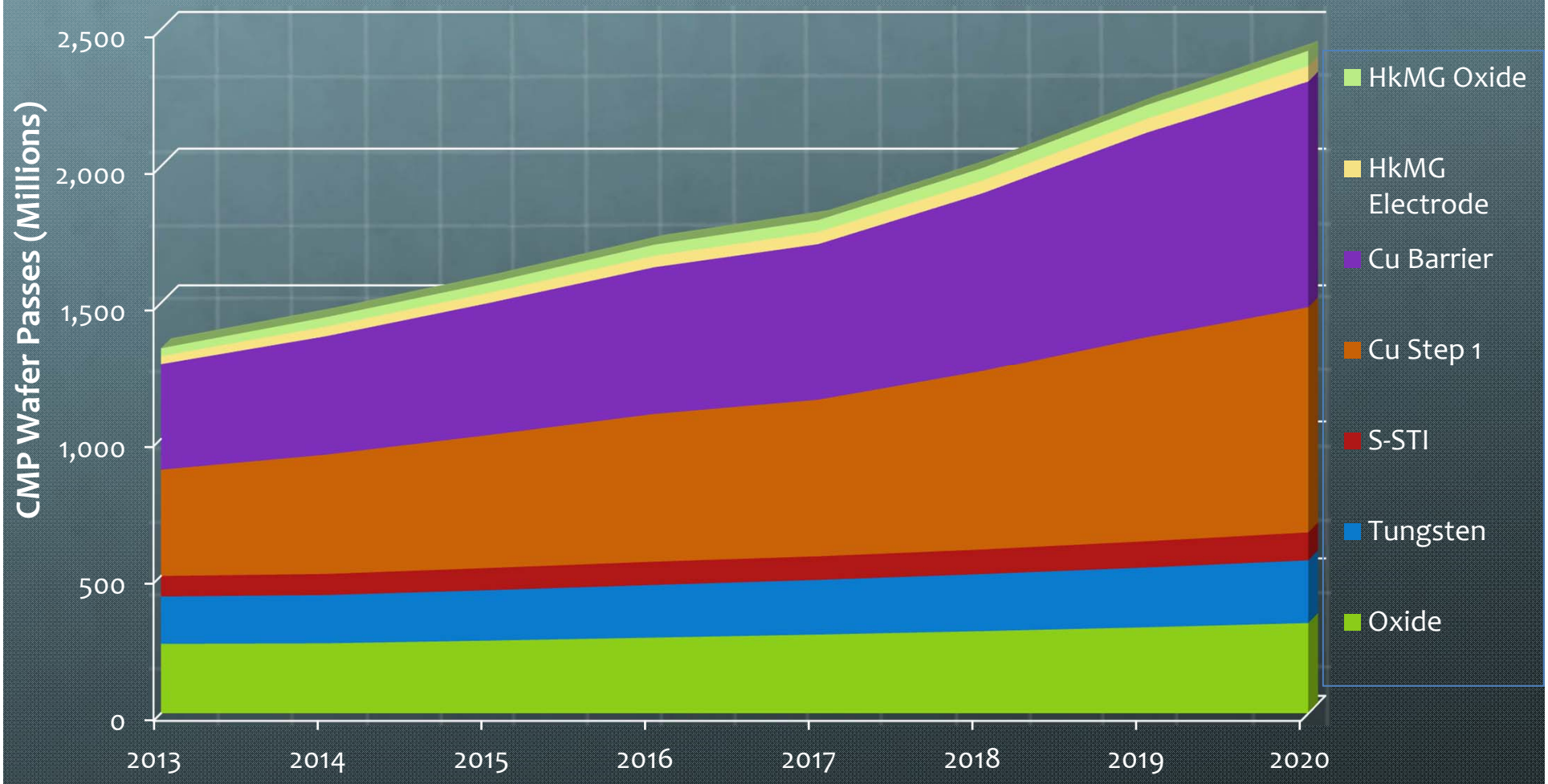
Wafer Starts per Year (200mm equivalent)



Below red area = 200mm wafer starts

Total CMP Wafer Passes Per Year



Total CMP Wafer Passes Per Year Data Table

Process	2013	2014	2015	2016	2017	2018	2019	2020
Oxide	252,194,538	254,270,666	264,129,183	275,016,530	286,086,880	298,605,904	312,603,496	328,022,576
Tungsten	172,392,643	175,510,224	183,441,835	191,695,610	198,994,801	207,787,083	217,756,759	228,710,087
S-STI	74,981,805	77,128,112	81,167,857	85,021,633	86,270,209	89,922,302	96,015,575	101,958,805
Cu Step 1	388,036,424	435,252,816	485,676,895	539,140,508	571,692,376	652,289,491	748,173,602	825,507,300
Cu Barrier	388,036,424	435,252,816	485,676,895	539,140,508	571,692,376	652,289,491	748,173,602	825,507,300
HkMG Electrode	29,515,806	35,211,600	37,060,483	41,783,042	44,444,033	46,584,325	50,610,236	56,251,784
HkMG Oxide	28,775,021	34,322,640	36,171,523	40,894,082	43,555,073	46,050,949	50,396,885	56,138,167

Industry News

- Pall introduces Ultipor® CMP filter for sub 14nm processes that is reported to provide >30% reduction in CMP related defects and 80% less trace metals than conventional melt-blown filters
- Applied Materials and Cadence Systems announce a joint development CMP optimization program focused on modeling of FEOL CMP process for 14nm and below
- Record silicon wafer area shipments in 2Q2015 (2.702 MSI),up 2.5% over prior quarter (2.637 MSI) according to SEMI's Silicon Manufacturers Group
- SUNY Polytechnic CMP Center:
  - Hitachi Chemical ramps up operations at its North American CMP lab, located at SUNY Poly CNSE's CMP Center
  - Air Products (NYSE APD) has a three-year contract to work with SUNY Poly and Sematech to research, develop and commercialize slurries and chemicals for post-CMP cleaning
  - Mitsubishi Chemical joined SUNY Polytechnic CMP Center - the agreement will allow the company access to advanced 300 mm wafers and to conduct research and development testing of its cleaning chemicals

Thank You!

Sue Davis

sdavis@techcet.com

+1 (480) 833.5905

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Section 2

QUARTERLY UPDATE

Electronic Gases

Bruce M. Adams

August 2015

www.Techcet.com
info@Techcet.com

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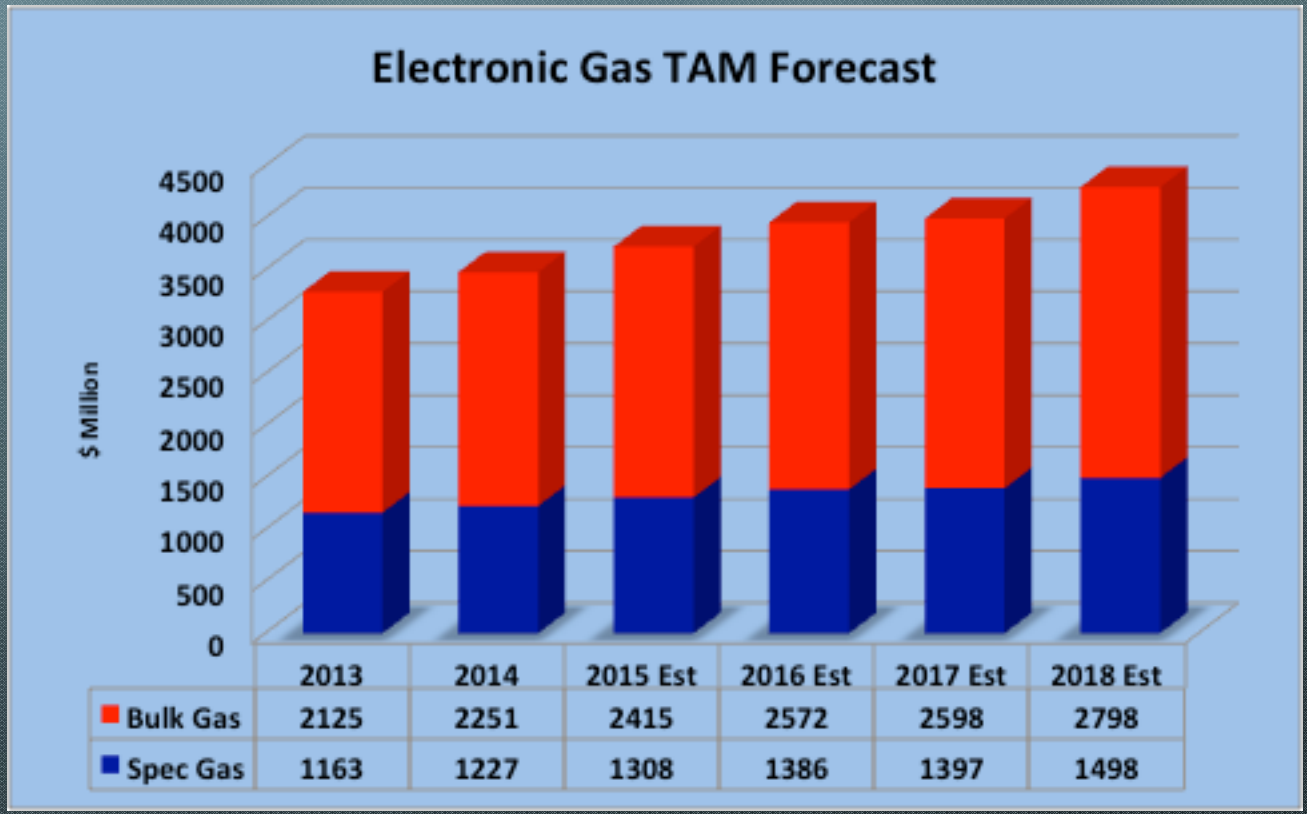
Updated Gas TAM Forecasts



	2013	2014	2015 Est	2016 Est	2017 Est	2018 Est
Bulk Gas	2125	2251	2415	2572	2598	2798
Spec Gas	1163	1227	1308	1386	1397	1498

Supply Alert – Neon Update

- Neon pricing is increasing and has gone up 10x over the last year. Prices are expected to start coming down in the next 12-15 months, as more capacity is being put on line and political tensions ease.
- See Update / Addendum to CMR Report on next page

Neon Update / Addendum, Continued

Neon continues to be of concern as the situation in the Ukraine region remains unsettled. 70% of the worldwide production of Neon comes from Eastern Europe. Iceblick accounts for 60% of this output with two plants, the main facility located in Odessa, Ukraine, the other in Moscow, Russia. The only Neon purification plant for Iceblick is located in Odessa. The conflict has impacted regional industrial output significantly with GDP declining 10% in 2014 and an additional 5% reduction is expected for 2015.

Neon is separated from air from large industrial oxygen plants co-located with steel mills. Not all oxygen plants have the equipment required to separate Neon as economic considerations are considered. Neon represents only 0.0018% of the atmosphere, requiring very large oxygen separation plants to make the extraction reasonable and economical. Most of the major steel mills in the Ukraine region are located in the Eastern part of the country, near Crimea, and in the conflict zone. Steel making is centered in the conflict-torn regions of Luhansk and Donetsk, where many of the factories have been forced to stop work.

A major factor in the decline of the Ukrainian GDP is due to the decreased manufacturing output of the steel mills in the region due to the reduction in demand for automobiles and the deceleration of rates of construction. The conflict has impacted the construction industry in Ukraine not only from the war efforts but the overall costs of development has increased with bank loan rates increasing from 19.5% to 30% within the last year. This has basically shut down any new local construction that may require steel or rebar. Additionally, a major portion of the Ukrainian steel output is exported to Russia. With the conflict, steel exports to Russia have dropped 38% in the first part of 2014 and could fall as much as 50% this year. With the large reduction in steel mill output, running the large oxygen plants are not needed, thus impacting neon output.

Currently there is no end in sight for the unrest in this region and this will continue to impact Neon output until negotiations conclude and Russia and Ukraine come to terms for a peaceful existence. Even if the situation is settled soon, the impact of industrial decline in the region will cause a major recession in Ukraine at least through 2018.

One slight positive note, Chinese steel production is growing significantly with many air separation plants being erected to support these mills. Unfortunately, purification before it can be used. Very limited purification currently exists in China. Prior to the , most of these plants do not have neon extraction capability. Of the ones that do, the quality of the neon extracted is very low and need Ukrainian/Russia conflict, the majority of the Chinese neon was being exported to Ukraine and Russia for purification then shipped back to China for use or further export. Even if decisions are made to add purification capability in China, these would not impact neon output until sometime in 2016. To date, no major supplier has announced any new large purification capability for China.

Prices over the past year have gone up >5X. Some say prices have increased as much as 10X over the past year. Techcet expects prices to level off and start declining over the next 15 months as there is talk of putting more capacity back on line in the Ukraine and political tensions ease.

Plant Closures / Discontinued Operations

- June 2015 – Air Products industrial gas facility in Saint Quentin Fallavier, SE of Lyon, France was attacked by terrorist activity, killing one non AP employee and causing a small gas explosion on site. Damage was minimal and the plant was operational within 4 days. The plant supplies industrial gases to the region.

Plant Closures / Discontinued Operations – Cont'd

- May 2015 – Incident at Matheson Gas Products Korea plant in Asan, Korea. The incident resulted in one fatality of a Matheson employee. Further details are being held until the investigation by the Korean government is complete. The facility was operational within one month. The facility manufactures Electronic specialty gas products and mixes.

Mergers and Acquisitions

- July 2015 - Belgian based Solvay has agreed to acquire New Jersey based Cytec for $5.5B. Solvay expects the deal to be finalized by year end. The deal will make Solvay the 2nd largest producer of aerospace composite materials. The acquisition will also combine the fluoro-chemicals business of Solvay with the Cytec Phosphine business. Cytec currently supplies the majority of the phosphine used in the Electronics industry, distributed through the major gas suppliers.

Mergers and Acquisitions Cont'd

- Korean based Wonik Materials has acquired a majority stake in Wisconsin based Nova-Kem LLC. Wonik was interested in their hexachlorodisilane (HCDS) manufacturing capability. HCDS is used as a precursor for Silicon deposition in ALD. Nova-Kem was noted for a large fire at their Illinois facility in June of 2013. Plant is fully operational as of June 2014. Wonik is an Electronic Specialty gas supplier and this acquisition will make them the world leader in HCDS supply. This also gives Wonik a footprint in the North American market for the first time.

Mergers and Acquisitions – Cont'd

- SK Group has expressed interested in taking over OCI Materials, the world's top supplier of Nitrogen Trifluoride (NF3) for the semiconductor and electronics industries. OCI, the parent company of OCI Materials, has put up for sale 5.18 million shares or 49.1% stake in the company. The stake is worth around 600 billion won ($535 million). Final decision is expected sometime in August.

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Badams@techcet.com

+1 (480) – 382-8336

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Section 3:

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Silicon Wafers

Ralph Butler

August 2015

www.Techcet.com
info@Techcet.com

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Market Segment

- Q2 each year typically delivers a strong selling performance over Q1. This year was no exception. Silicon wafer producers shipped increased silicon representing a growth in sales.
- In calendar quarter 2 (Mar – Jun), the top silicon wafer producers delivered positive revenue and income quarter to quarter and year to year with the exception of SunEdison Semiconductor that saw a retrenchment of sales (-3.5% y0y) and Q2 operating loss indicating shrinking market share.
- Prices remain flat for the segment.

Financials

Siltronic
- Q2 2015 (Jan 1 – Mar 31 Sales increased by 17% yoy
- Q2 2015 (Jan 1 – Mar 31 EBITDA increased by 11% yoy

Shin Etsu Handotai – S.E.H.
- Q1 2015 (Apr 1 – Jun 30) Net Sales increased by 6.6% yoy
- Q1 2015 (Apr 1 – Jun 30) Operating Income increased by 5.7% yoy
- Q1 2015 (Apr 1 – Jun 30) Ordinary Income increased by 11% yoy

SUMCO
- Q1 2015 (Apr 1 – Jun 30) Net Sales increased by 12.9% yoy
- Q1 2015 (Apr 1 – Jun 30) Operating Income increased by 45.6% yoy
- Q1 2015 (Apr 1 – Jun 30) Ordinary Income increased by 48.2% yoy
- Q1 2015 (Apr 1 – Jun 30) Net Income increased by 39.5% yoy

SunEdison Semiconductor
- Q2 2015 (Jan 1 – Mar 31) Net Sales decreased by 3.5% yoy
- Q2 2015 (Jan 1 – Mar 31) Operating Income (loss) -$5M
- Q2 2015 (Jan 1 – Mar 31) Net Income (loss) -$15.5M

LG Siltron not reported

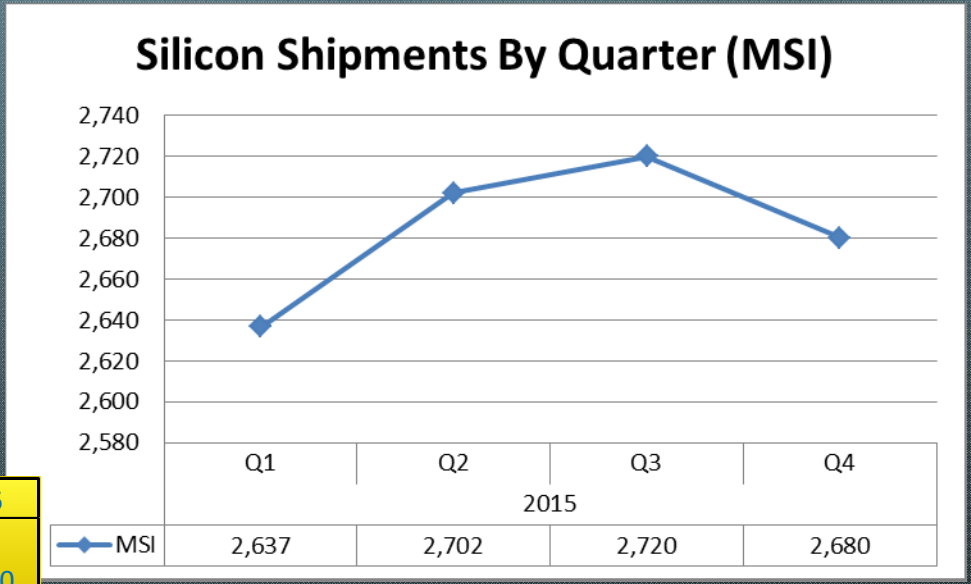
Segment News

- July 2015 - Global Foundries announced 22FDX, its 22nm FD SOI, readiness on Soitec 300mm FD SOI substrates
- SunEdison (solar) sold its remaining 10.6 million shares of SunEdison Semiconductor for $193M in June. SunEdison Semiconductor will get none of proceeds.

Silicon Shipments

We anticipate a 6% increase in Year on year total annual shipments with flat pricing

	2012	2013	2014	2015	2016
Area Shipments (MSI)	9,031	9,067	10,089	10,700	10,900
YoY Change (MSI)	0%	0%	10%	6%	2%
Revenues ($B)	8.7	7.5	7.6	8.1	8.3
YoY Change (Revenue)	-14%	-16%	1%	6%	2%
ASP	0.00096	0.00083	0.00075	0.00076	0.00076
YoY Change	-14%	-16%	-10%	0%	1%



Q2Q shipments decrease in Q4 after seasonal Q3 build up

Forecast Comments

- **Overall SEMI market indicating flattening growth with capital equipment book-to-bill trending downward.**

Plant Closures / Discontinued Operations

- SunEdison Semiconductor Ltd.
  - Announced the shutter of its 200mm wafer factory in Ipoh, Malaysia.

Thank You!

Rbutler@techcet.com

+1 (480) - 382-8336

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Sputtering Targets

Christopher Michaluk

August 2015

www.Techcet.com
info@Techcet.com

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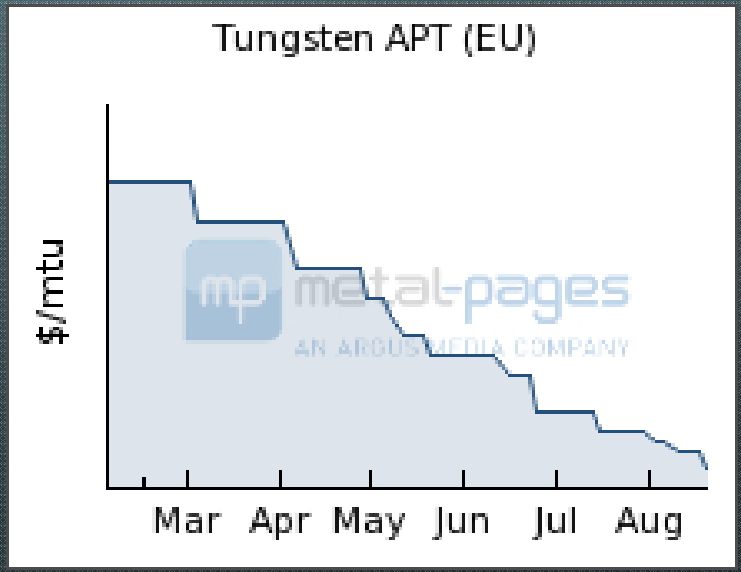
Forecast Updates: Target Pricing

- Although the commodity metal price index has decreased 7.64% during the first half of 2015, the change in raw materials price is not expected to impact Cu, Ti, or Cu target prices.
- Tungsten raw material prices continued to soften though 2015, forcing a downward correction in W price forecast.
- Tantalum prices in 2016 and beyond were adjusted downward due to growing competition



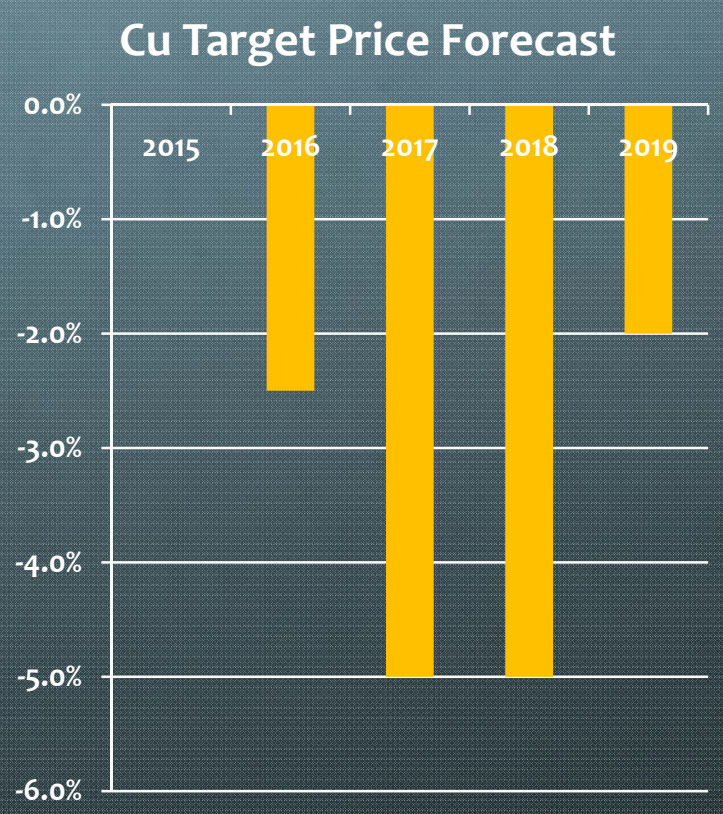
Supply Chain Updates

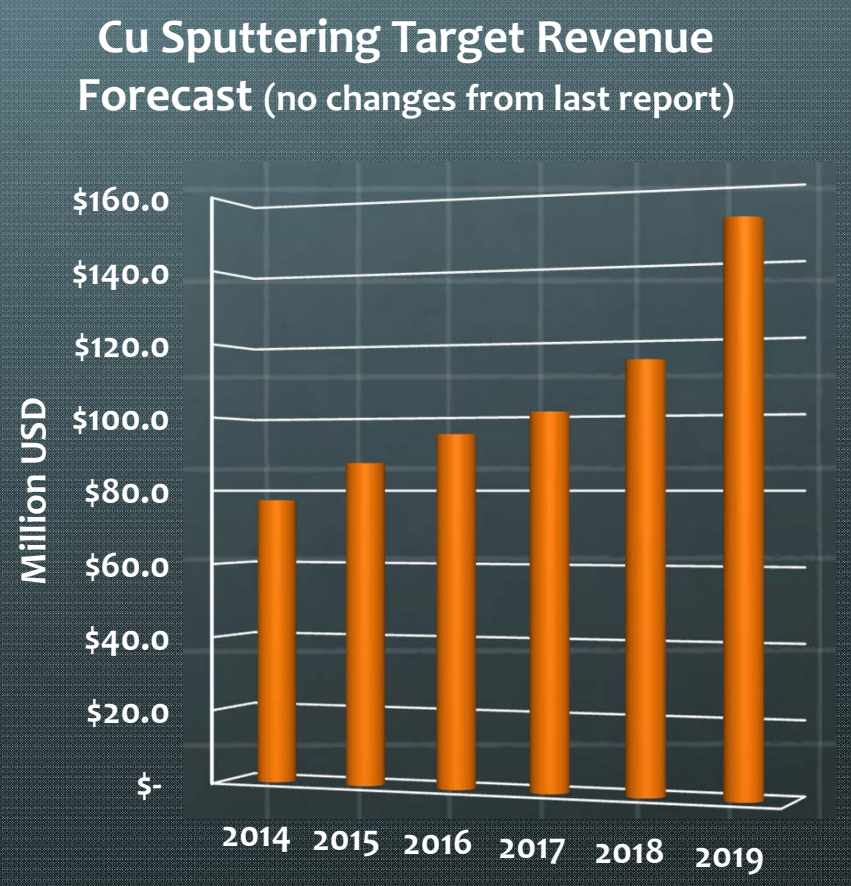
- GAM (Global Adv. Metals, previously known as Cabot Super Metals) now actively marketing intermediate Ta metal forms once again.
- KFMI strengthening their offering of Ta targets, more competitive pricing for a variety of configurations.

Forecast Updates: Target Demand

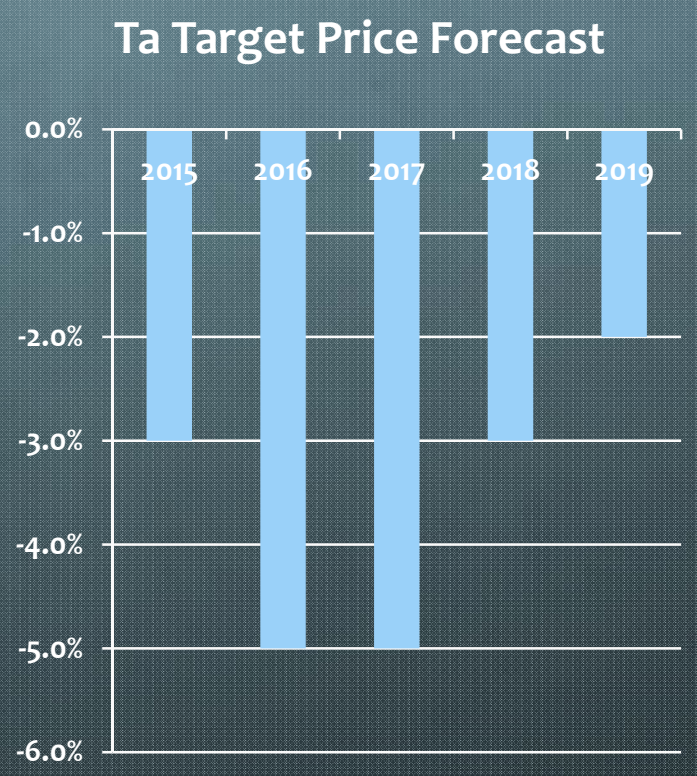
- Adjustments to Techcet's Wafer Start Forecast have been incorporated into the Wafer Pass Forecast Model, and adjustments to the 5-year Sputtering Targets demand forecasts were calculated.

Forecast Updates: Copper

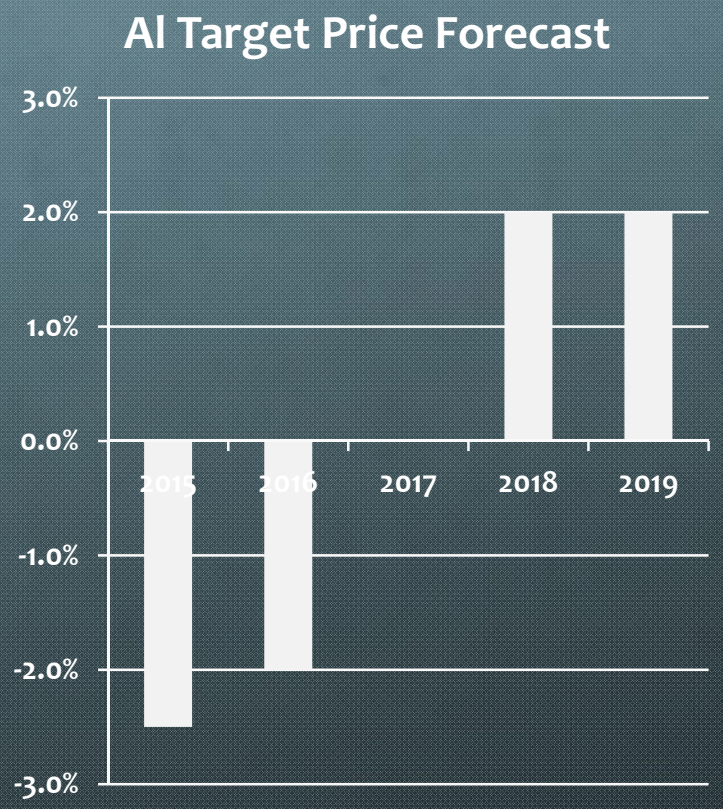


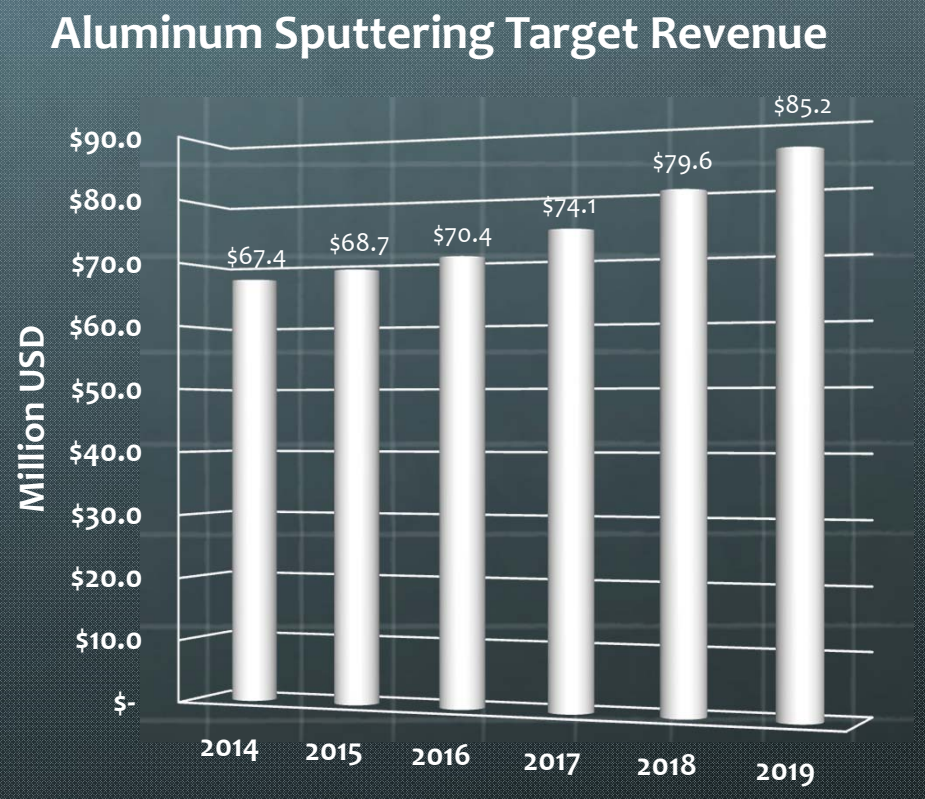


Forecast Updates: Tantalum

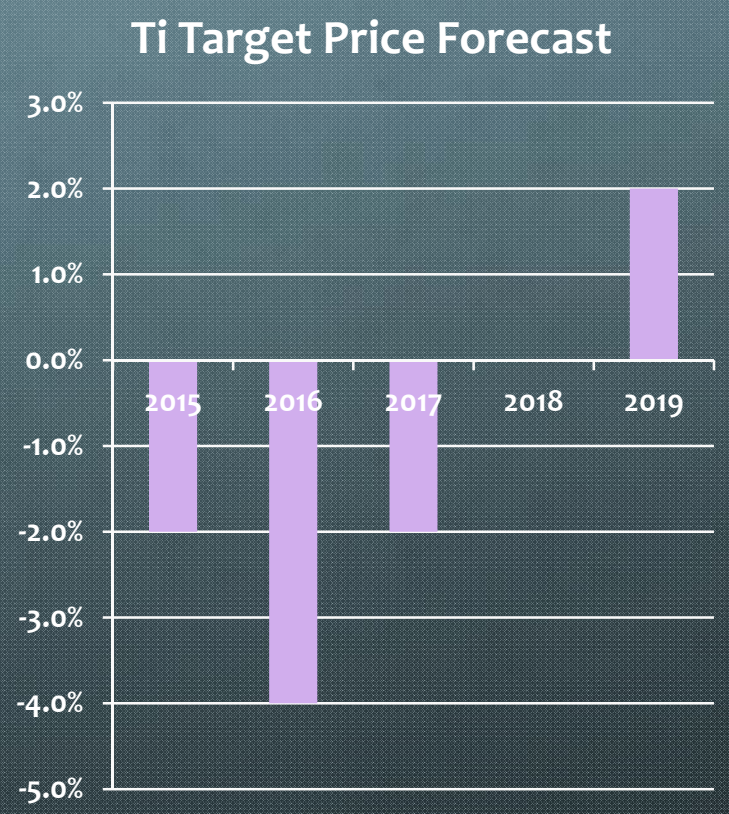


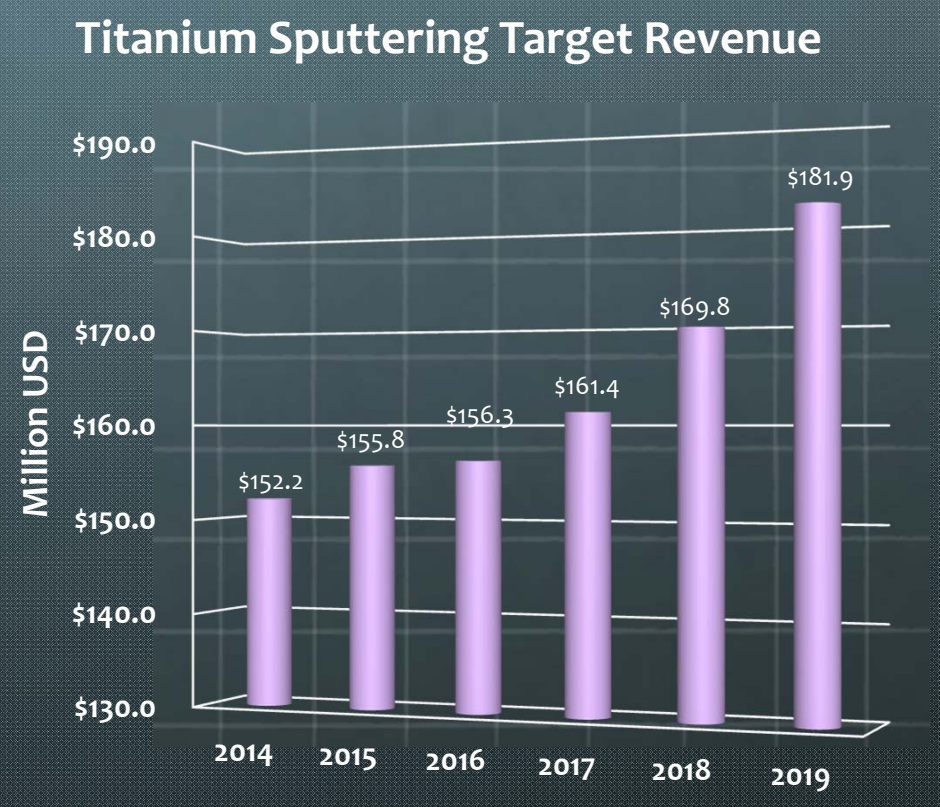
Forecast Updates: Aluminum



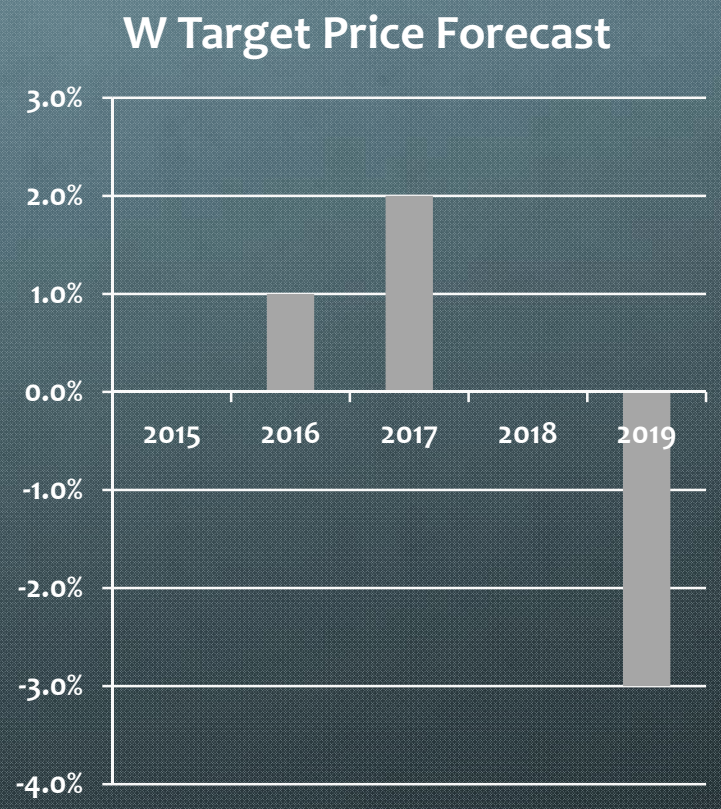


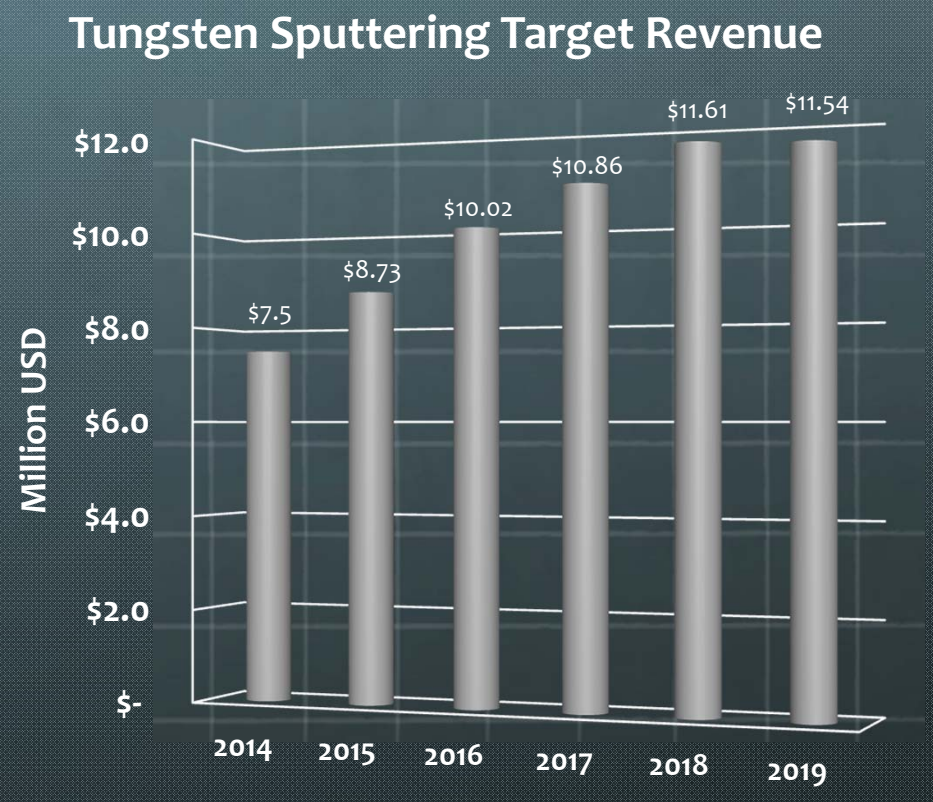
Forecast Updates: Titanium





Forecast Updates: Tungsten





Thank You!

cmichaluk@techcet.com

+1 (520) 977-5274

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Section 5:

QUARTERLY UPDATE

Wet Chemicals

Yu Bibby, Ph.D. and Chris S. Blatt

August 2015

www.Techcet.com
info@Techcet.com

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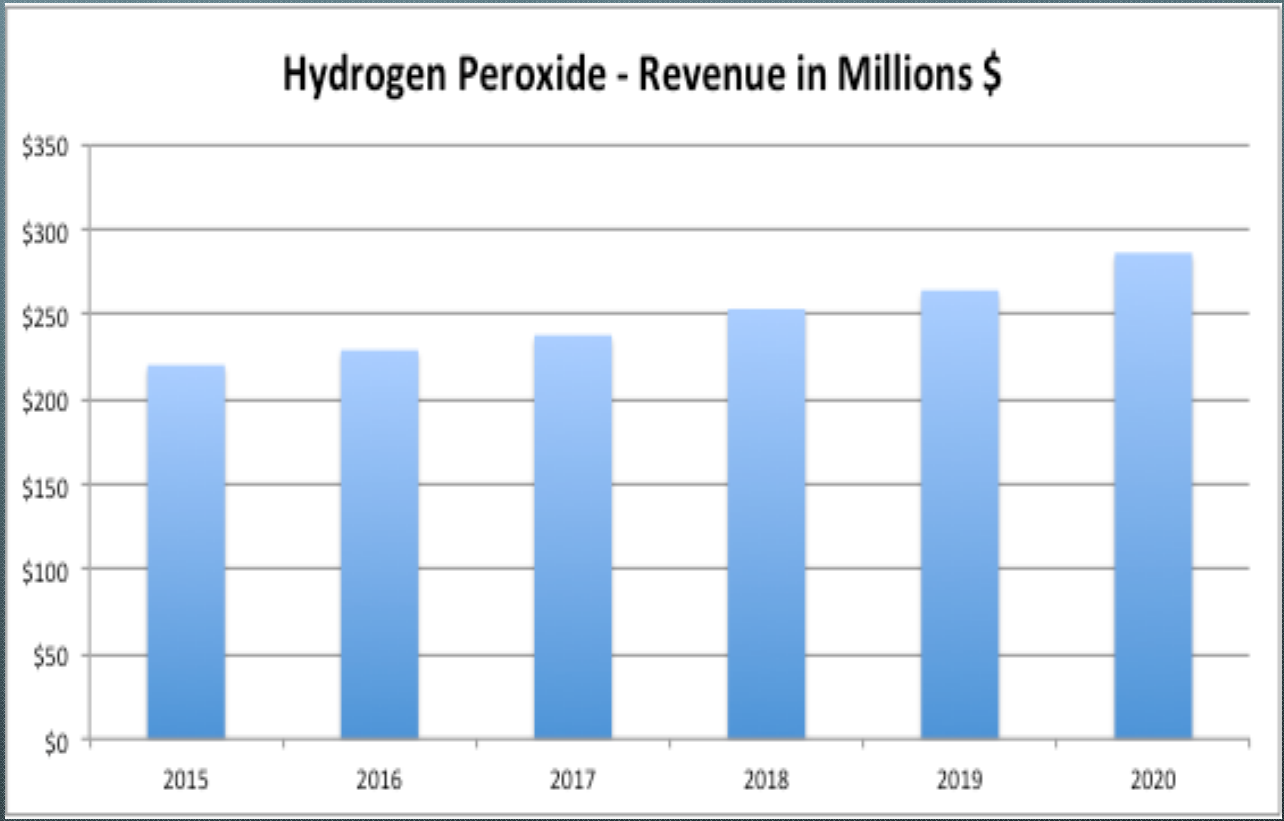
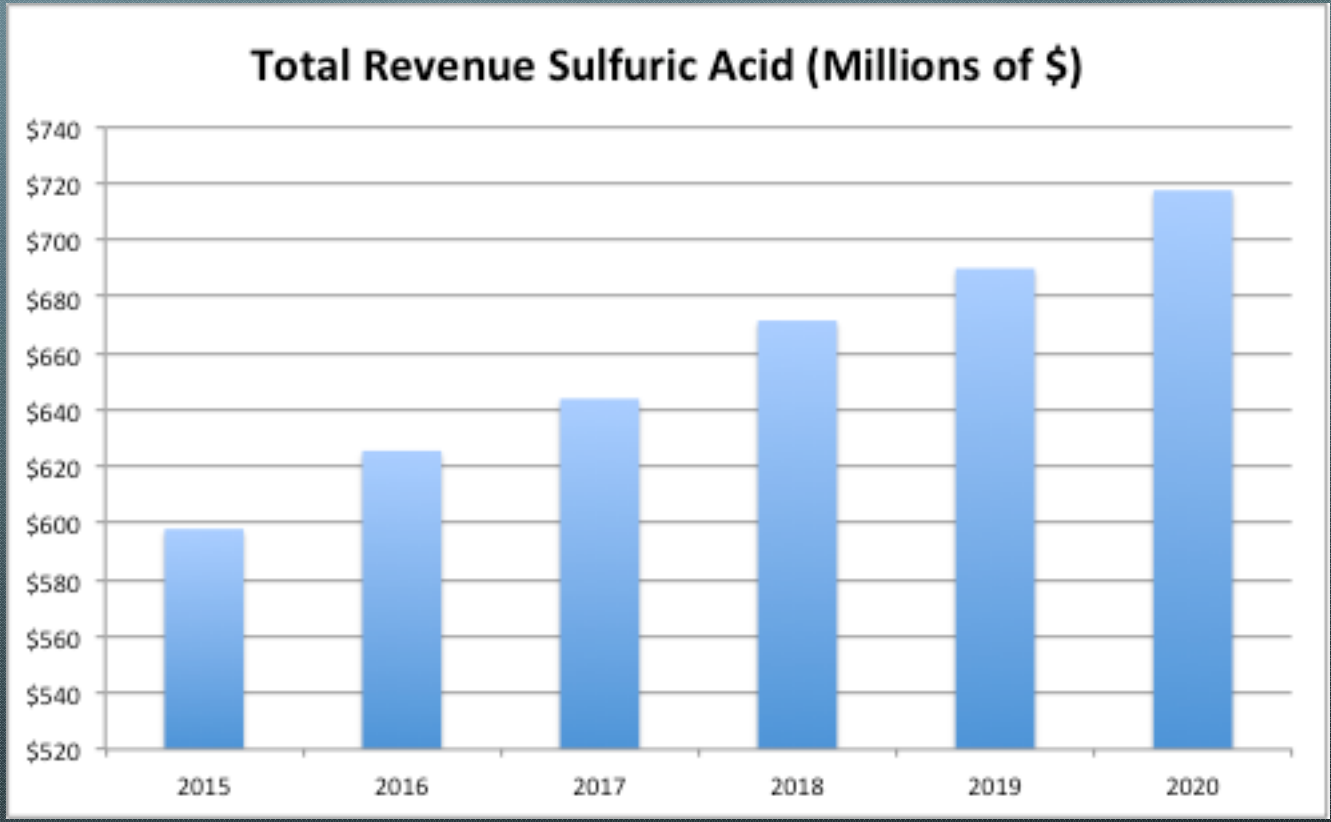
Hydrogen Peroxide



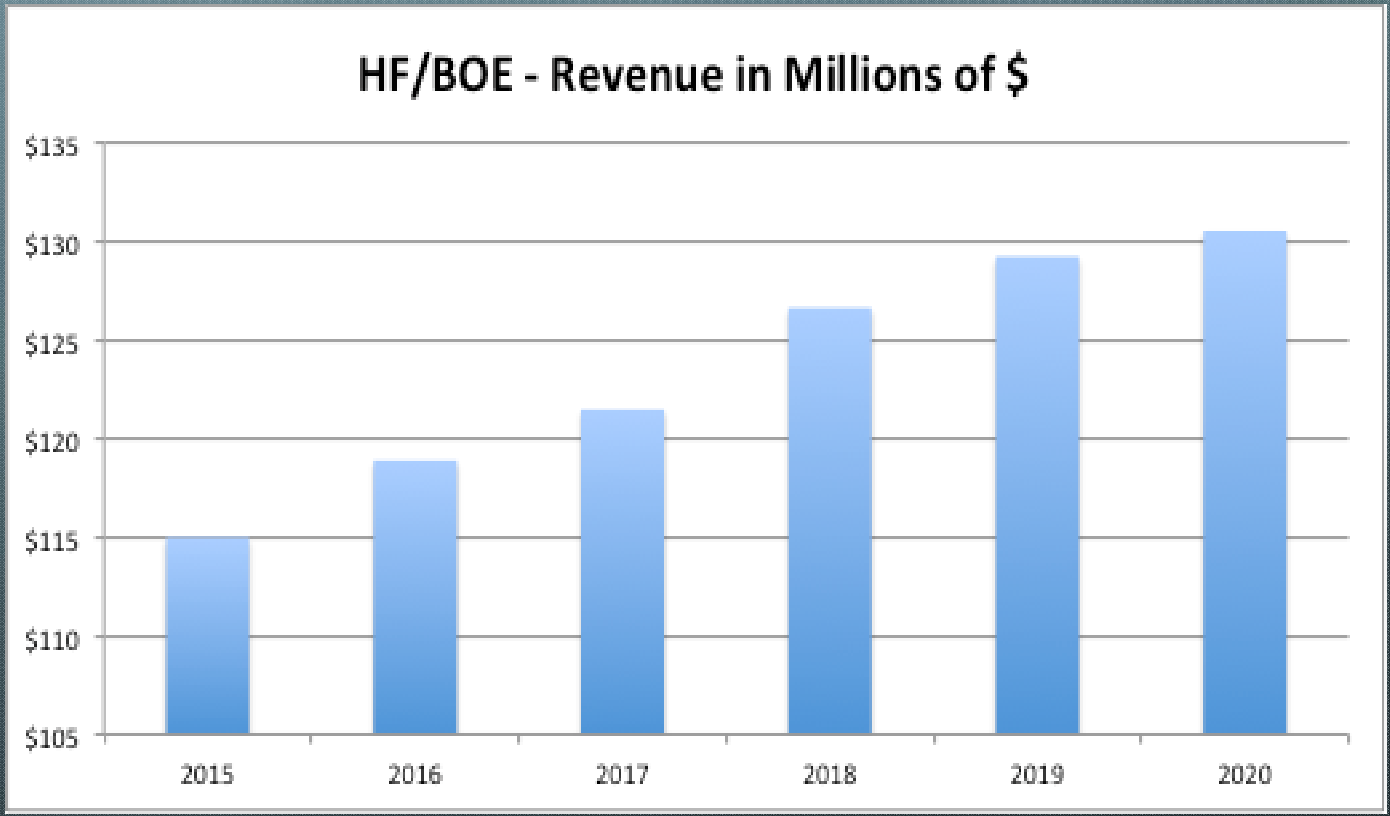
No significant change since issue of report

Sulfuric Acid



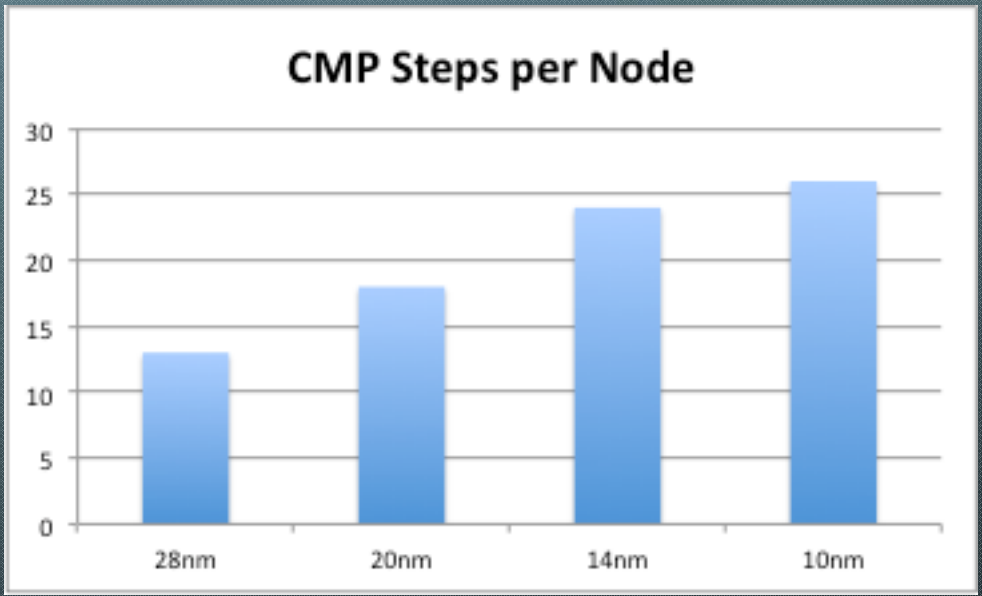
No significant change since issue of report

HF/BOE



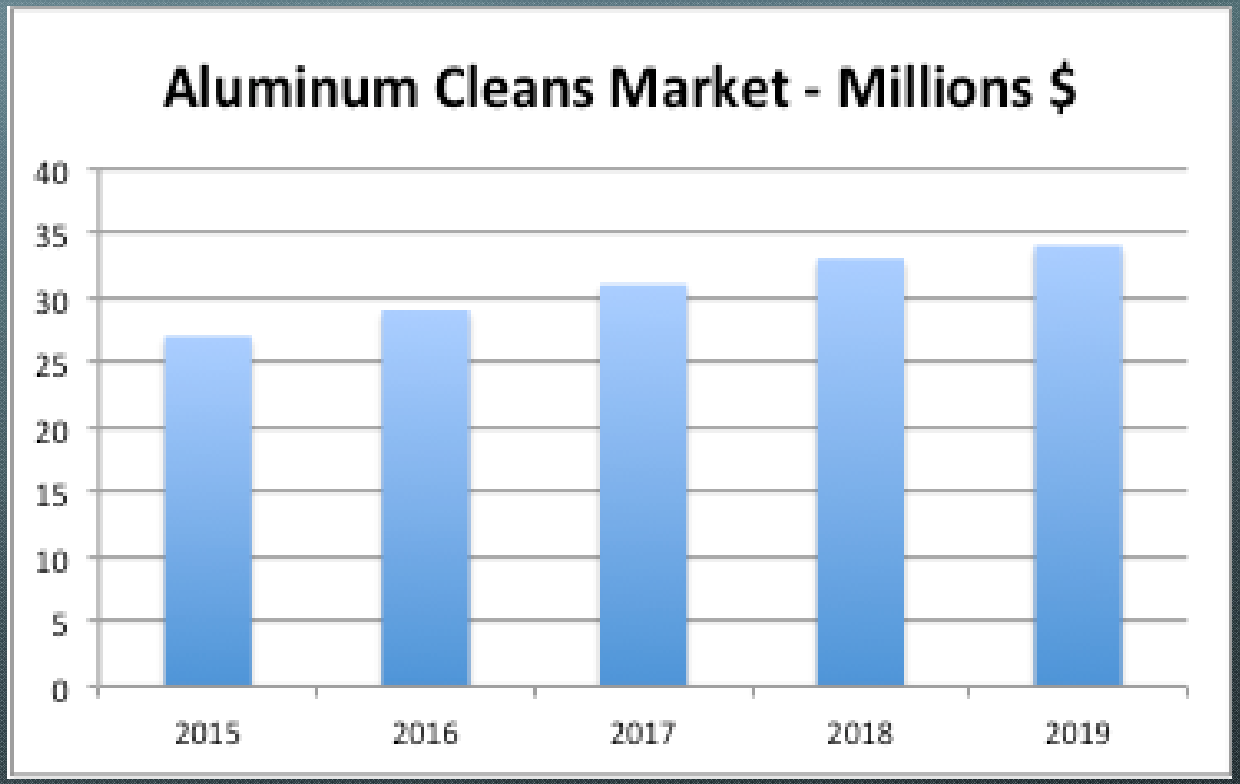
No significant change since issue of report

CMP Process Steps



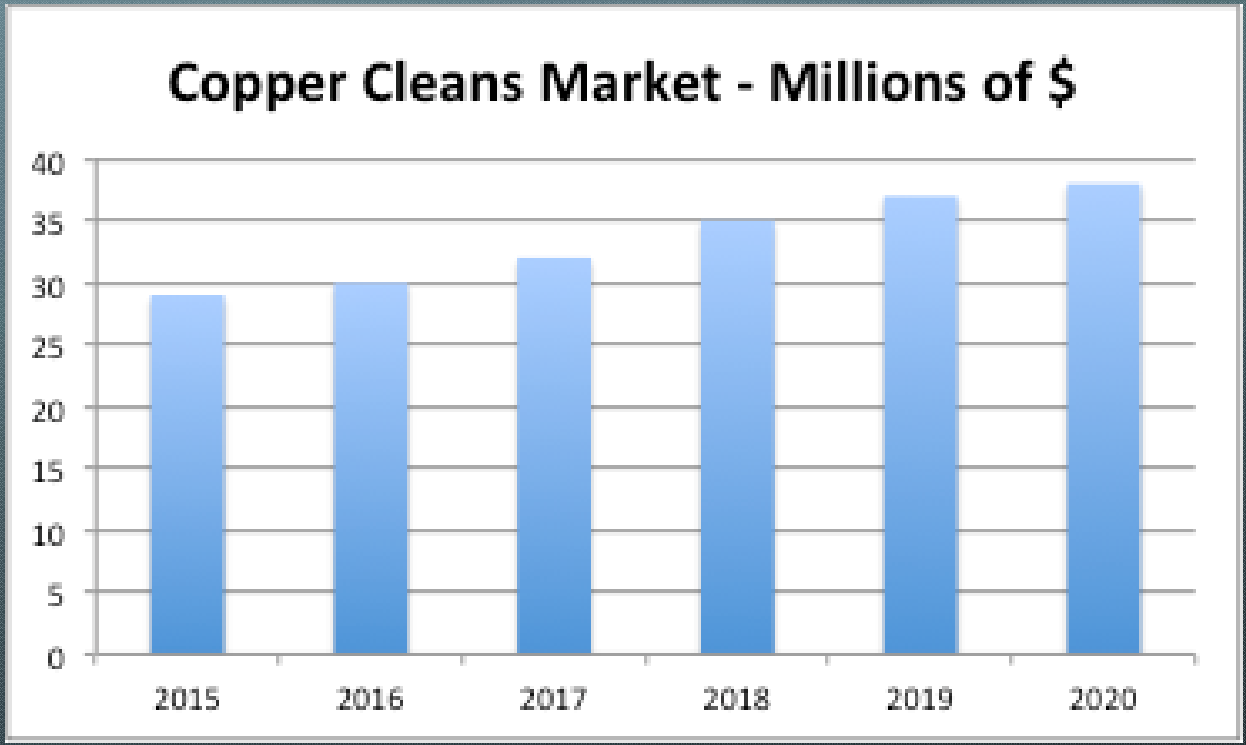
CMP continues to add process steps at each node

Al Clean Market



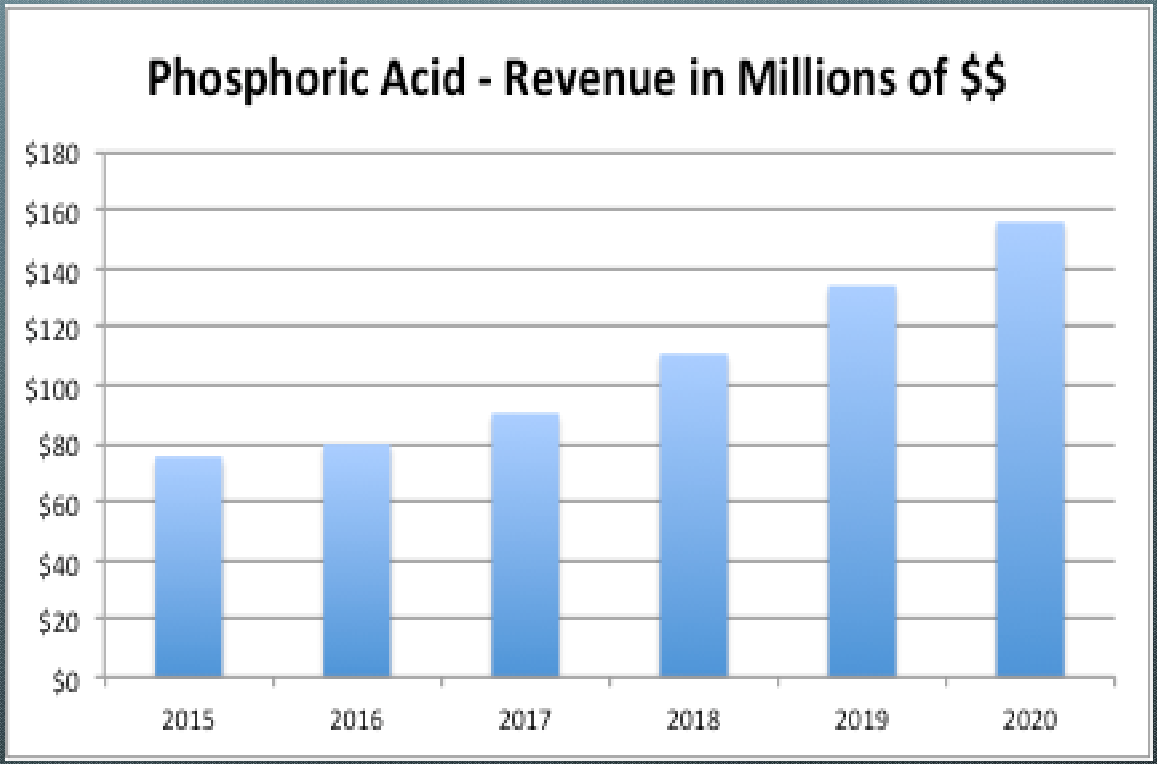
No significant change since issue of report

Cu Clean Market



No significant change since issue of report

Phosphoric Acid



Expected unusually high growth :

- **Increased number of process steps with spray tools causing an unexpected increase in usage - possible shortage**

Mergers and Acquisitions

- On June 1, 2015, private equity firm Apollo Global Management has agreed to acquire OM Group, a producer of metal-based chemicals, for $1 billion. Apollo will then sell OM's electronic chemicals and photomasks business to Platform Specialty Products for $365 million.

- OM Group, Inc. (NYSE: OMG), a technology-driven diversified industrial company, announced on June 1, 2015 that it has entered into a definitive agreement to be acquired by funds managed by affiliates of Apollo Global Management, LLC (NYSE: APO) for $34.00 per share in cash. The purchase price represents a premium of approximately 28% over OM Group's closing share price on May 29, 2015.

- Platform Specialty Products ("Platform") (NYSE: PAH) will acquire OM Group's Electronic Chemicals and Photomasks businesses, which combined represented approximately $28 million of adjusted EBITDA in 2014, from the Apollo Funds in two separate transactions for total cash consideration of $365 million.

- Platform believes there is a synergy opportunity in excess of $20 million over the next two years from the combination of these complementary assets. Following the transactions, the Apollo Funds will own OM Group's Magnetic Technologies, Battery Technologies and Advanced Organics businesses.

Thank You!

Ybibby@techcet.com
Csblatt@exateck.com
Lshonroy@techcet.com
+1 (480) - 382-8336

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Section 6:

QUARTERLY UPDATE

Rare Earths News

Yu Bibby, Ph.D.

August 2015

www.Techcet.com
info@Techcet.com

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RARE Earths News

by Y. Bibby, Ph.D.

- On June 25, 2015, Molycorp, which mines rare-earth 15 elements at Mountain Pass, Calif., the only miner and producer of rare-earth elements in USA has filed for Chapter 11 bankruptcy after failing to turn a profit since 2011. In its court papers said that it had secured $225 million in new financing and brokered an agreement with creditors to restructure its $1.7 billion in debt.

- Five years ago, Molycorp was flush with a market value $6 billion because China, the world's dominant supplier of rare earths, had restricted their exports. But those fortunes faded when China did away with the quotas following a ruling from the World Trade Organization, and as magnet and battery makers turned to rare earth alternatives.

- Today, 90% of the world's rare earths are produced in China. It would be closer to 100% but for Molycorp's output of cerium, lanthanum, neodymium, and praseodymium oxides and carbonates . If Molycorp were to stop operating, China would once again be essentially the only rare-earth game in town.

- Mining companies outside China are now caught in a bind: They are working to increase output at a time when lower prices make it extremely difficult to turn a profit. Looking ahead, Molycorp will need to both increase production and obtain higher prices to survive, goals that can be mutually exclusive in today's market.