

THE DEVELOPMENT OF FORMULATED CLEANS FOR ENABLING PACKAGING PROCESSES IN HETEROGENEOUS INTEGRATION

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Business of Cleans Conference

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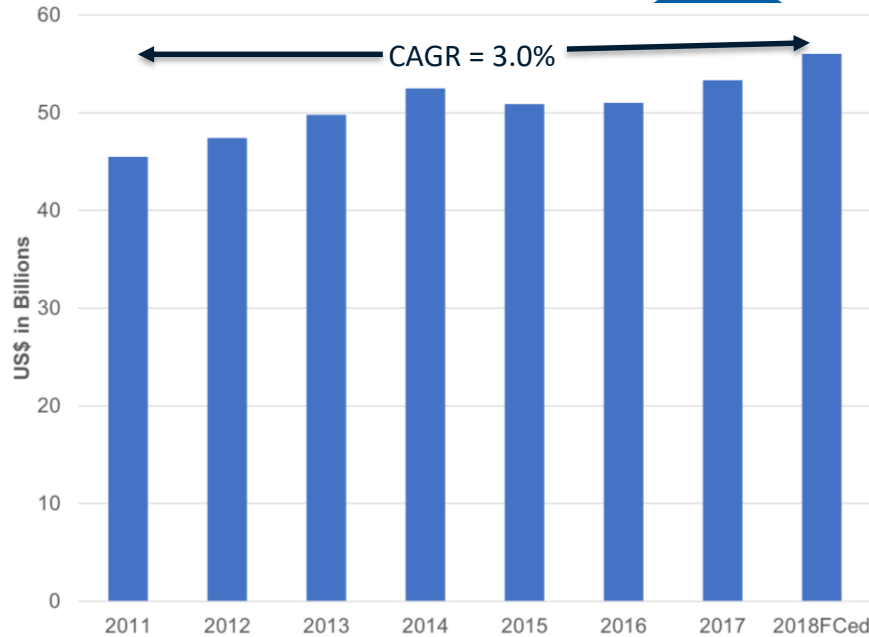
- ❑ Market Drivers and Changes for Formulated Packaging Cleans
- ❑ Challenges & Advancements of Formulations Development
- ❑ Summary

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PACKAGING INDUSTRY VALUE CHAIN*

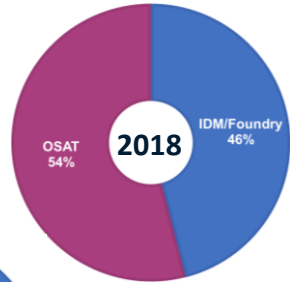
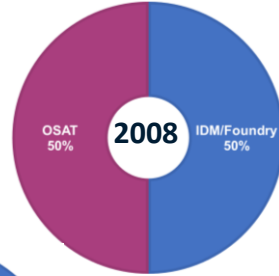
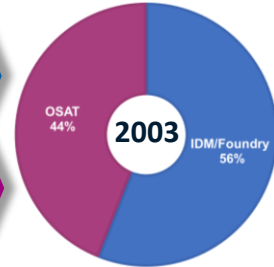
Packaging(Assembling)/Testing

- ❑ Sales ~ \$56 B in 18', ~ 80% packaging/assembling vs. ~ 20% testing
- ❑ Growing at a CAGR of 3.0 % ('11-18')
- ❑ Increasing OSATs (Outsourced Assembling & Testing) presence (03' – 18')



*Source: Yole.

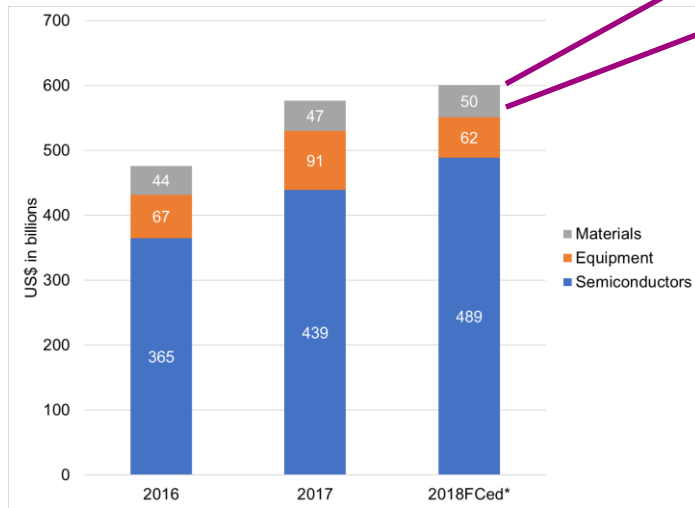
VERSUM
MATERIALS



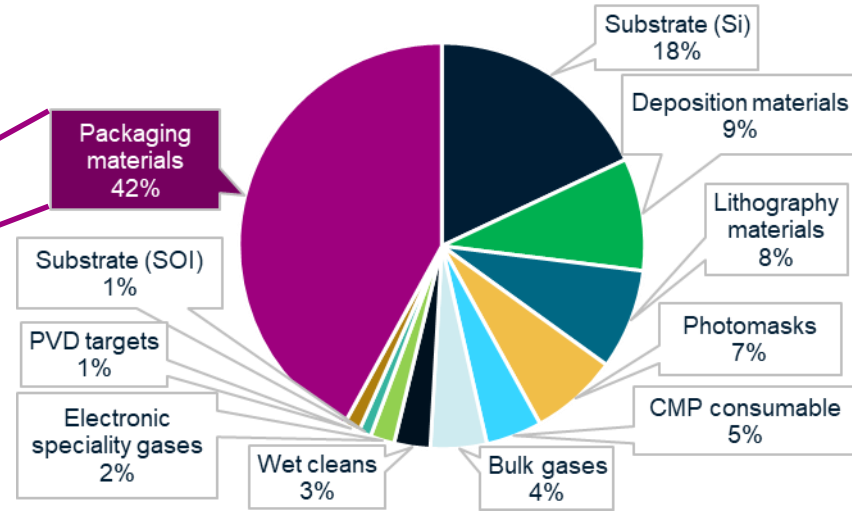
INDUSTRY VALUE CHAIN*

Packaging Materials (including ceramic and flexible)

- ❑ Sales ~ \$21 B in 18'
- ❑ ~ 42 % of total microelectronics materials sales in 18'
- ❑ Growing at a CAGR of 7.7 % ('16-18')
- ❑ Core to SEMI Innovation and Productivity



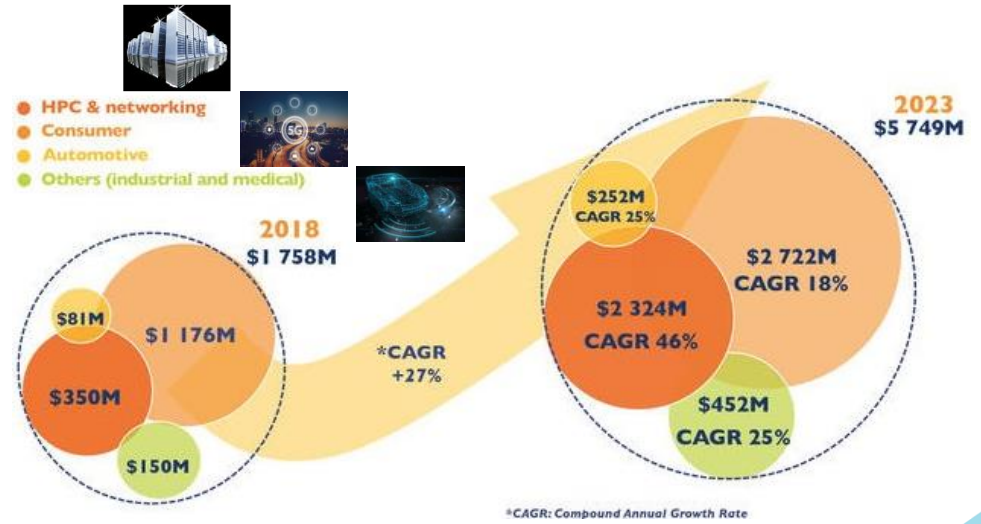
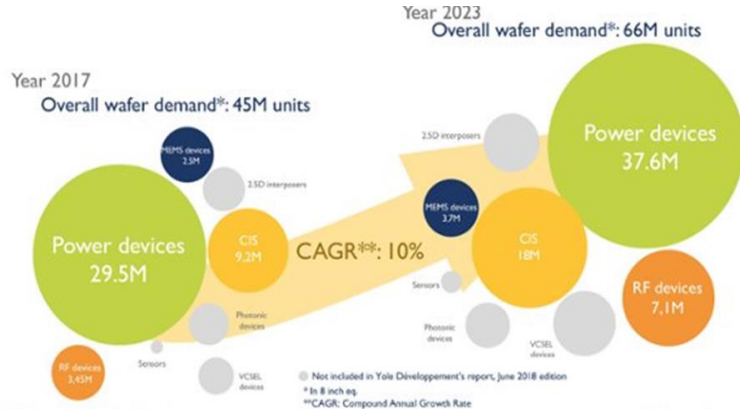
*Source: IC Insights; SEMI, Techcet & Linx consulting.



WHAT DRIVES FORMULATED PACKAGING CLEANS?

Industry Volume Growth

- ☐ Silicon MSI/Wafer Starts
 - 10% CAGR of MSI (17' – 23')
- ☐ Revenue growth
 - 27% CAGR of revenue (18' – 23')



Source: Yole Development, 2017/2019



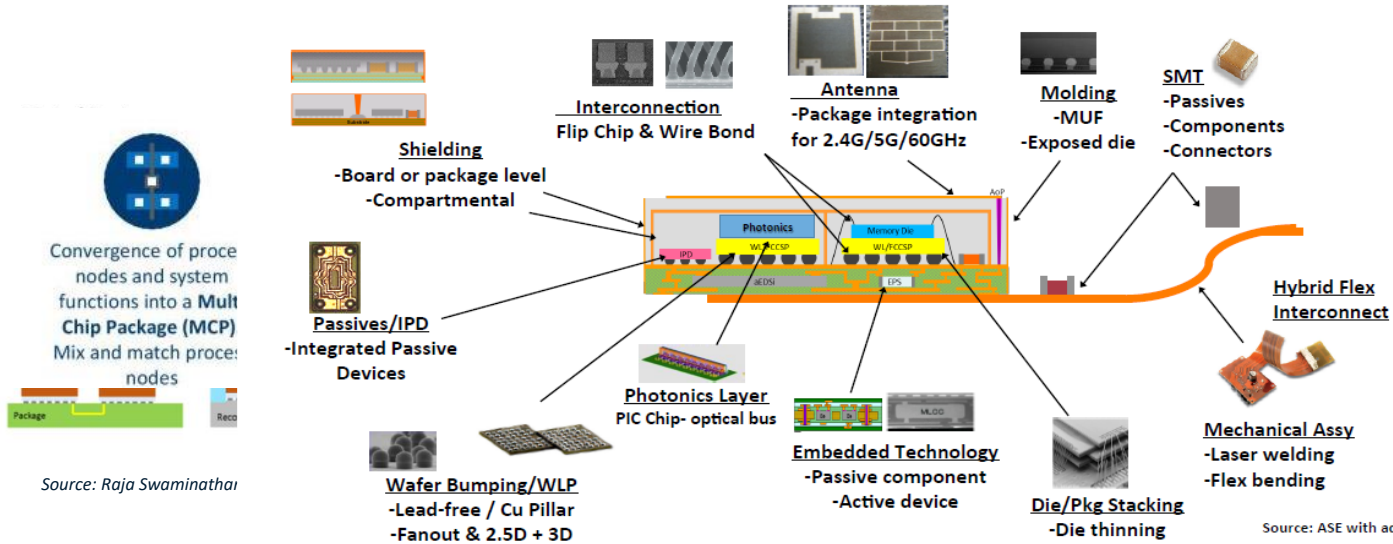
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GREATER NEEDS FOR INNOVATION

Technology Changes

New Heterogenous Architectures

- ❑ 2.X/3D integrations
 - More options & more materials

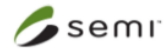


Source: Raja Swaminatha

Intel INFO® / 2.XD?;
CoWoS® / 2.5D?

intel EMIB® / 2.5D?

Source: ASE with additions



Electronic/Photonic SiP through Heterogeneous Integration

ROADMAP OF PACKAGING CLEANS

Application	Targeted materials	Type of materials	Offerings	Single chip packaging cleans	Advanced Packaging cleans	
					2.5X D	3D
PERRs (Post Etch Reside Removers) /PARRs (Post Ash Reside Removers)	Photoresists (PRs)	Polymers (Acrylic, et. al.) Fluorinated residue	ACT® XT1100 Series ACT® NE Series Dynastrip® DL9150			
TFRRs (Thick Films Resists Removers)	Photoresists (PRs)	Polymers (Acrylic, et. al.)	ACT® VFS Series Dynastrip® AP7880T Dynastrip® AP7900C Dynastrip® AP1050		 	
Temporary Bond Clean (Device and Carrier)	Adhesives	Polymers (Silicone, polyimide, et. al.)	Dynasolve®219			
Selective Si etching	Substrate	Silicon	ACT® VSE Series			
Surface cleaning	Interconnects	Al, Cu, et. al.	BPS100/106/600 BPS 729A/B			



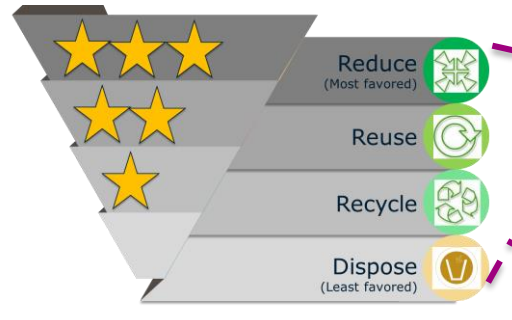
HVM adopted
Customer-site qualified
Developmental offerings

OUR COMMITMENT TO SAFER AND ENVIRONMENTALLY-FRIENDLY PRODUCTS

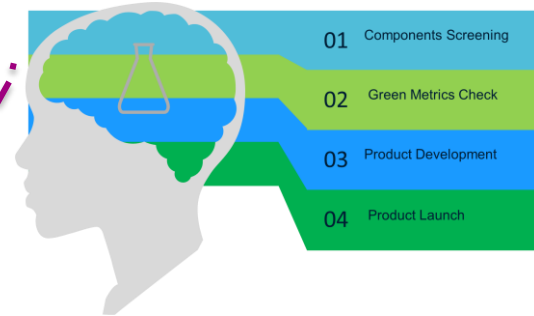
Our Principles



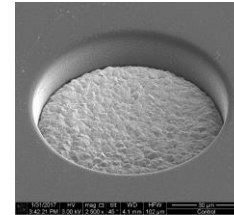
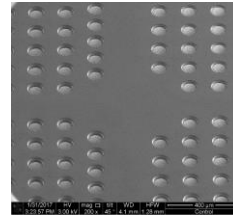
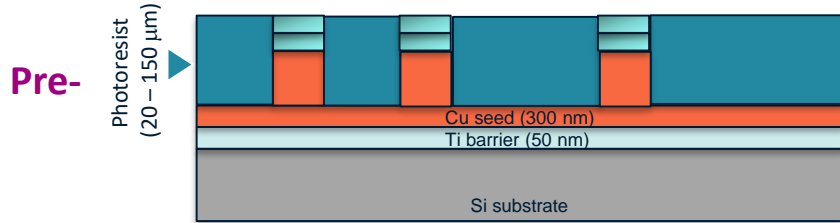
Our Values



Our Strategy

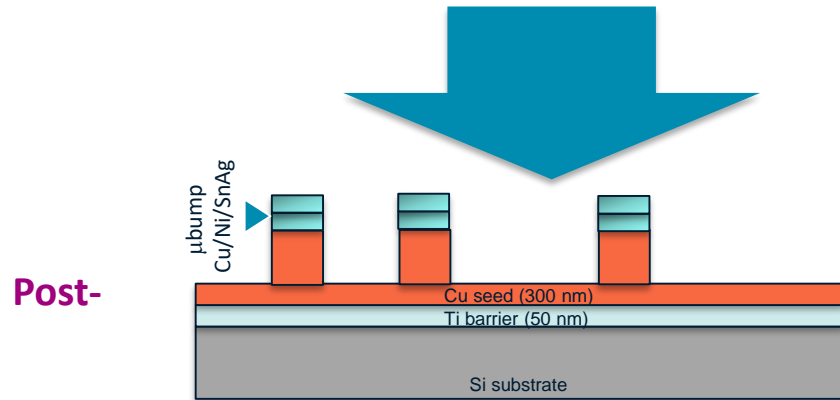


GREATER NEEDS FOR INNOVATION SELECTIVE PACKAGING CLEANS

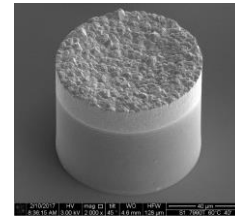
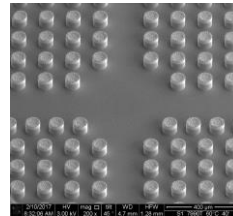


DynaStrip® DL9150

Compatible with
RDLs/μbumps/pillars/PI/PBO



t = 40 mins
T = 60 °C
(TOK CE5000)



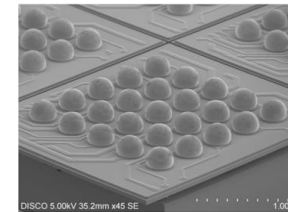
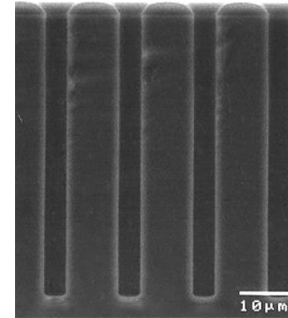
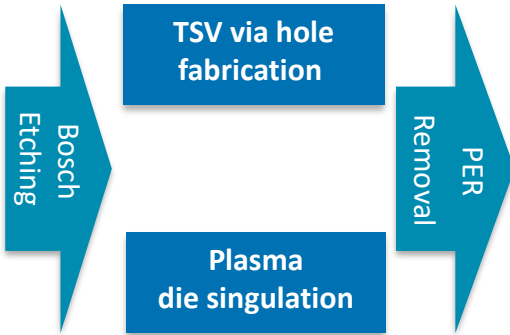
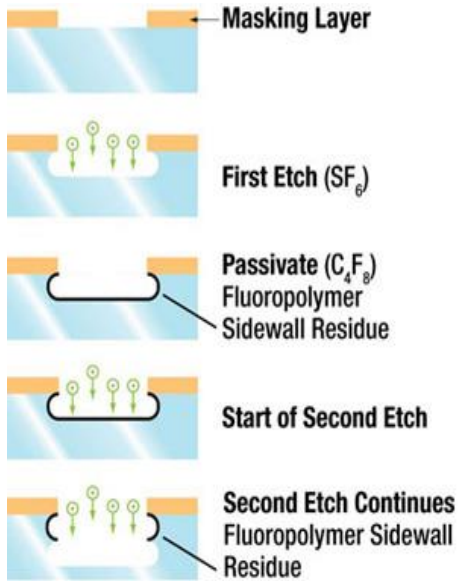
DynaStrip® 7990T

Compatible with
RDLs/μbumps/pillars/PBO



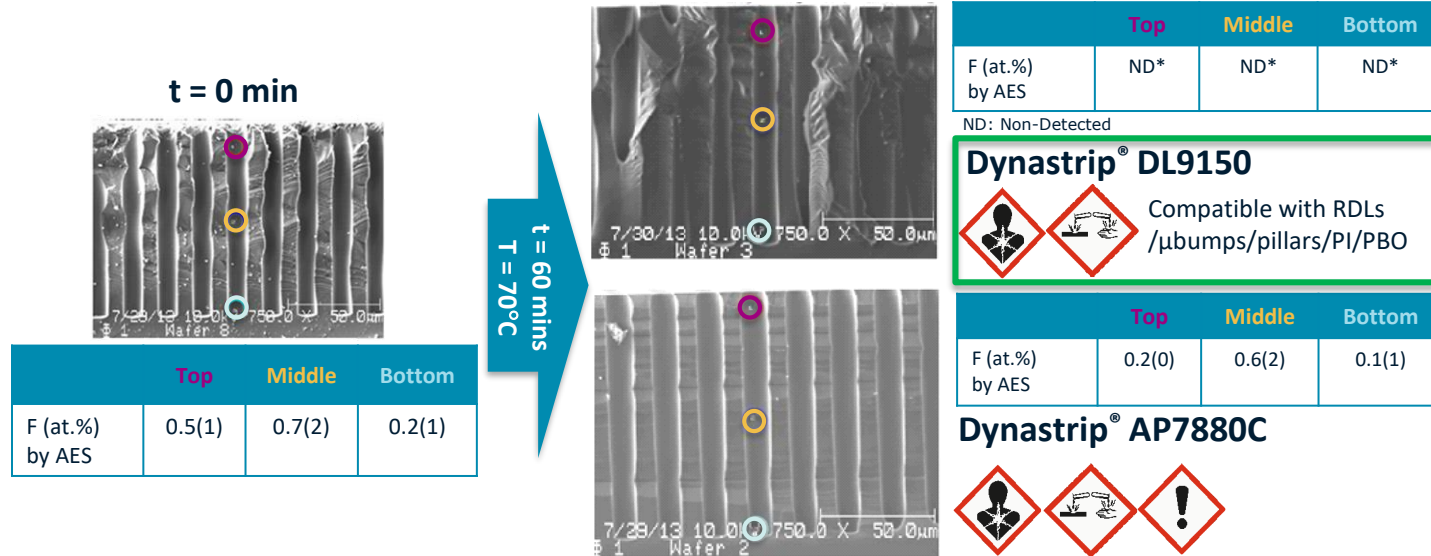
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SELECTIVE PACKAGING CLEANS

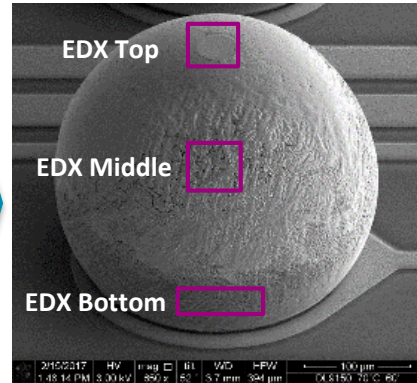
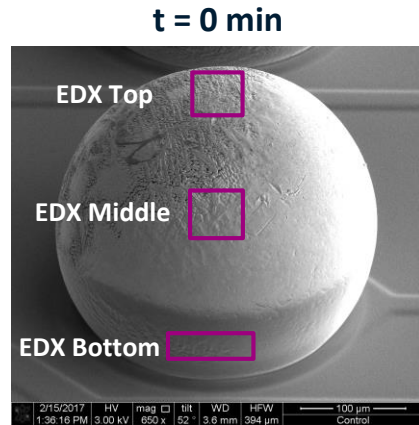


* Image source: 3M

POST ETCH RESIDUE (PER) CLEANS IN PACKAGING PROCESSES



POST ETCH RESIDUE (PER) CLEANS IN PACKAGING PROCESSES*



	Top	Middle	Bottom
F (at.%) by EDX	2.2(5)	6.9(5)	1.5(1)

	Top	Middle	Bottom
F (at.%) by EDX	0.6(1)	ND	ND

ND: Non-Detected

ACT[®] VSE



Compatible with
Sn/SiO₂/Dicing tape

* Janet Hopkins, "Optimizing Surface Chemistry After Plasma Dicing", *SemiconEuropa*. 2018.

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CRITERIA FOR SUCCESS AS WE APPROACH THE 2020S

Customer Relationships

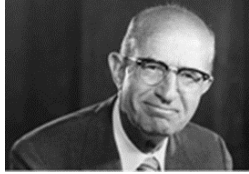
Innovation Capabilities and Intellectual Property

Global Infrastructure and Reliable Supply

Diversified Portfolio

SEMI
Next Generation
Formulated Packaging Cleans
Supplier

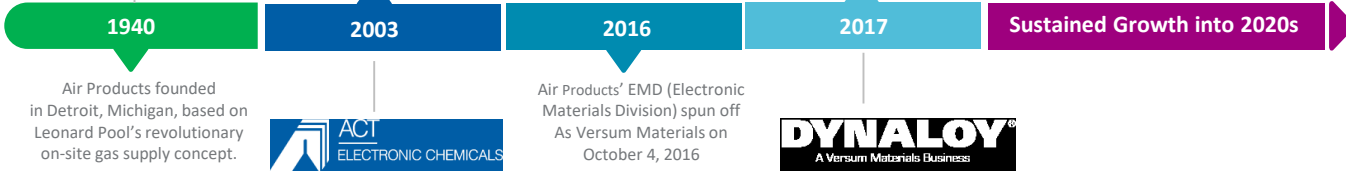
MATERIAL SUPPLIERS ARE CONSOLIDATING



Air Products and Chemicals acquired Ashland Specialty Chemical Company's electronic chemicals unit.



Acquired Dynaloy LLC, a leading supplier of formulated cleaning solutions from Eastman Chemical Company (NYSE: EMN).



THANK YOU !

