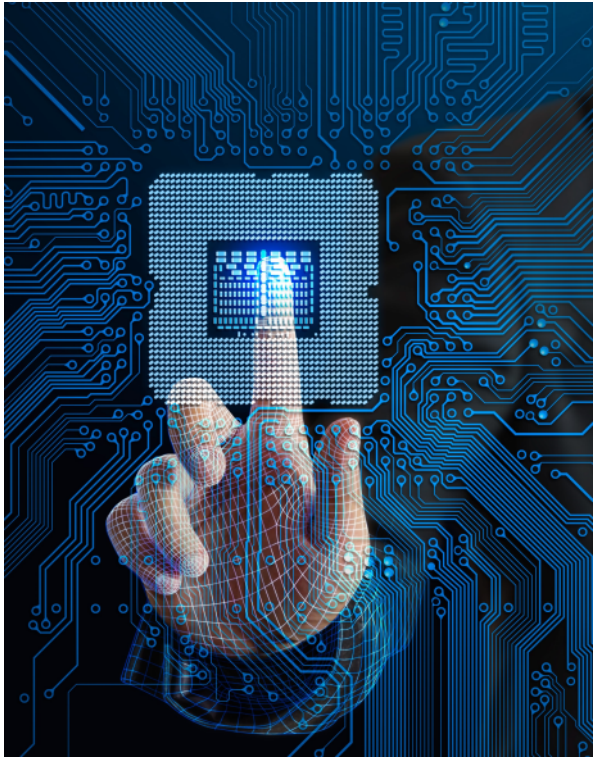
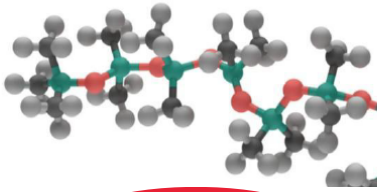
Dow Silicone Volatility



Presented by Clinton Whiteley
January 2017

consumer.dow.com/pcb

Defining Silicones



Organic | **Silicone** | **Inorganic**

- Easier to process
- Range of properties
- Less thermally stable

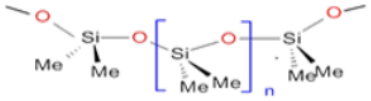
Silicones have properties that combine glass and organic polymers

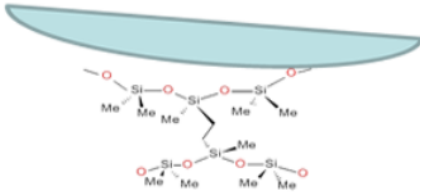
- Thermally stable
- Optically excellent
- Complex to process

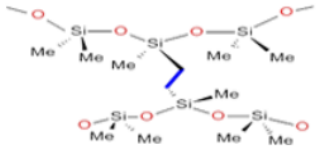
	Acrylic	PU	Epoxy	Silicone
Thermal Stability	●●	●	●●	●●●
Moisture Resistance	●	●	●●	●●●
Solvent Resistance	●●●	●	●●●	●●
Adhesion	●●	●●●	●●●	●●
Repairable	●●●	●●	●●●	●●

●● Low ● Medium ● High

Silicones Chemistry







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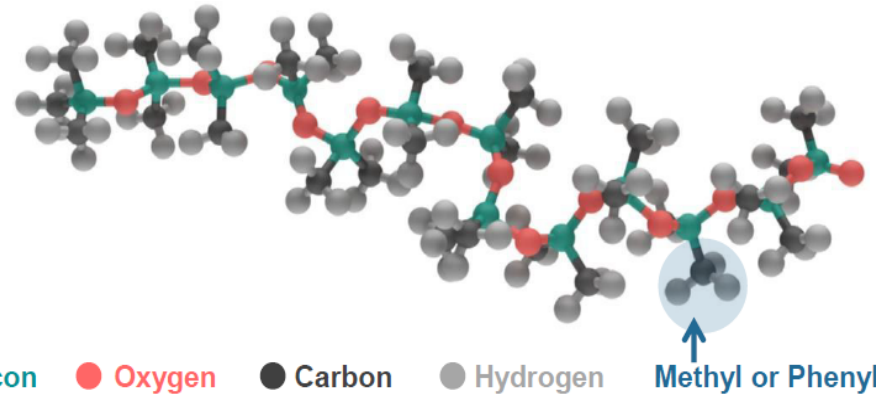
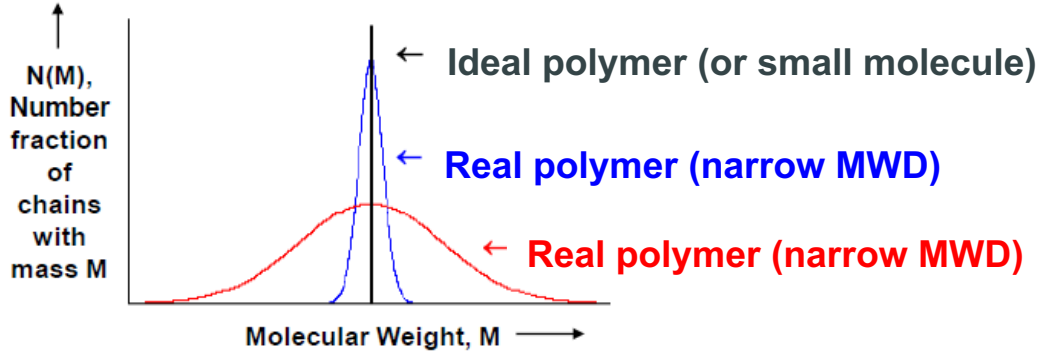
M	T	Q	D
$Me_3SiO_{1/2}$	$MeSiO_{3/2}$	$SiO_{4/2}$	$Me_2SiO_{2/2}$

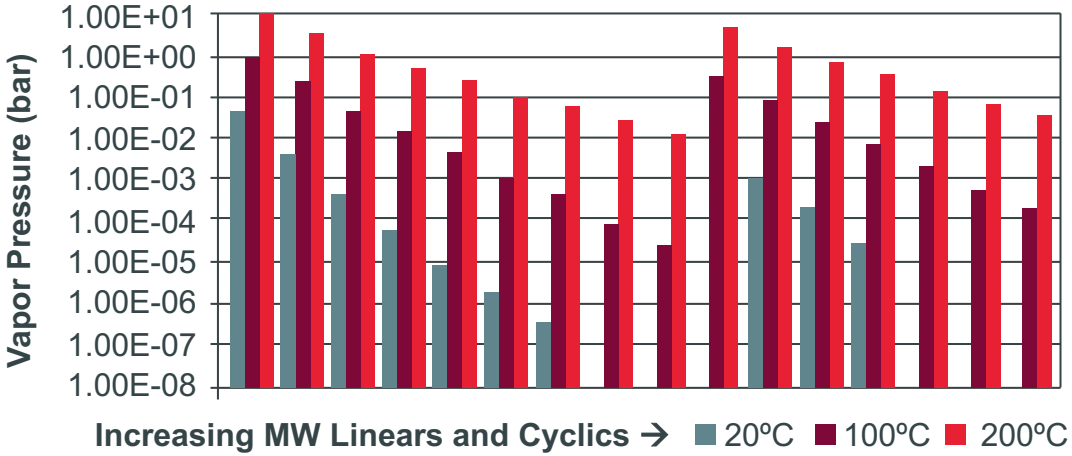


Silicone Volatiles in High Vacuum

Silicone Volatile Contamination		
Potential Issue	**Devices**	**Contamination Process**
Contact resistance	Relays	Thermal oxidation in arcing
	Electrical Motors	
	Potentiometers, Switches	
	Remote Controls (Keypads)	
Fogging	CD/DVD player	Chemisorption or Chemical Reaction
	Lenses in Optical Devices	Condensation
	Aerospace devices	Atomic Oxygen Degradation
	Headlamps, Light bulbs	UV degradation
Poisoning	Sensors and Gas Detectors	Adsorption, chemisorption, chemical reaction
	Catalytic Oxidation Devices	

Silicone Production

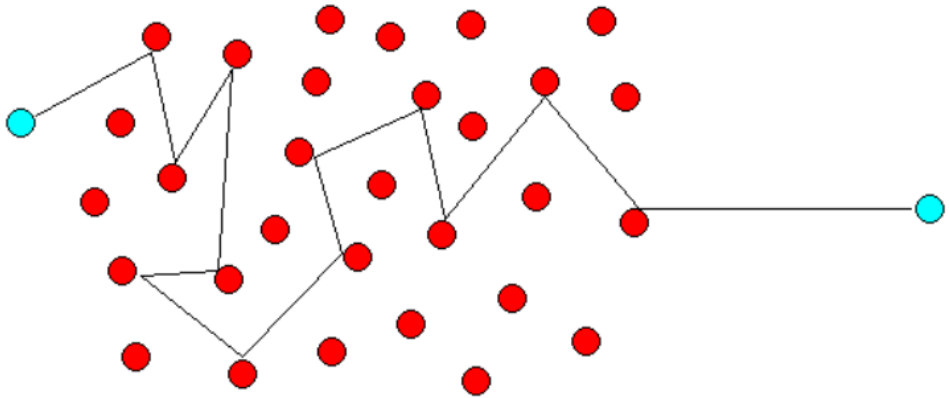




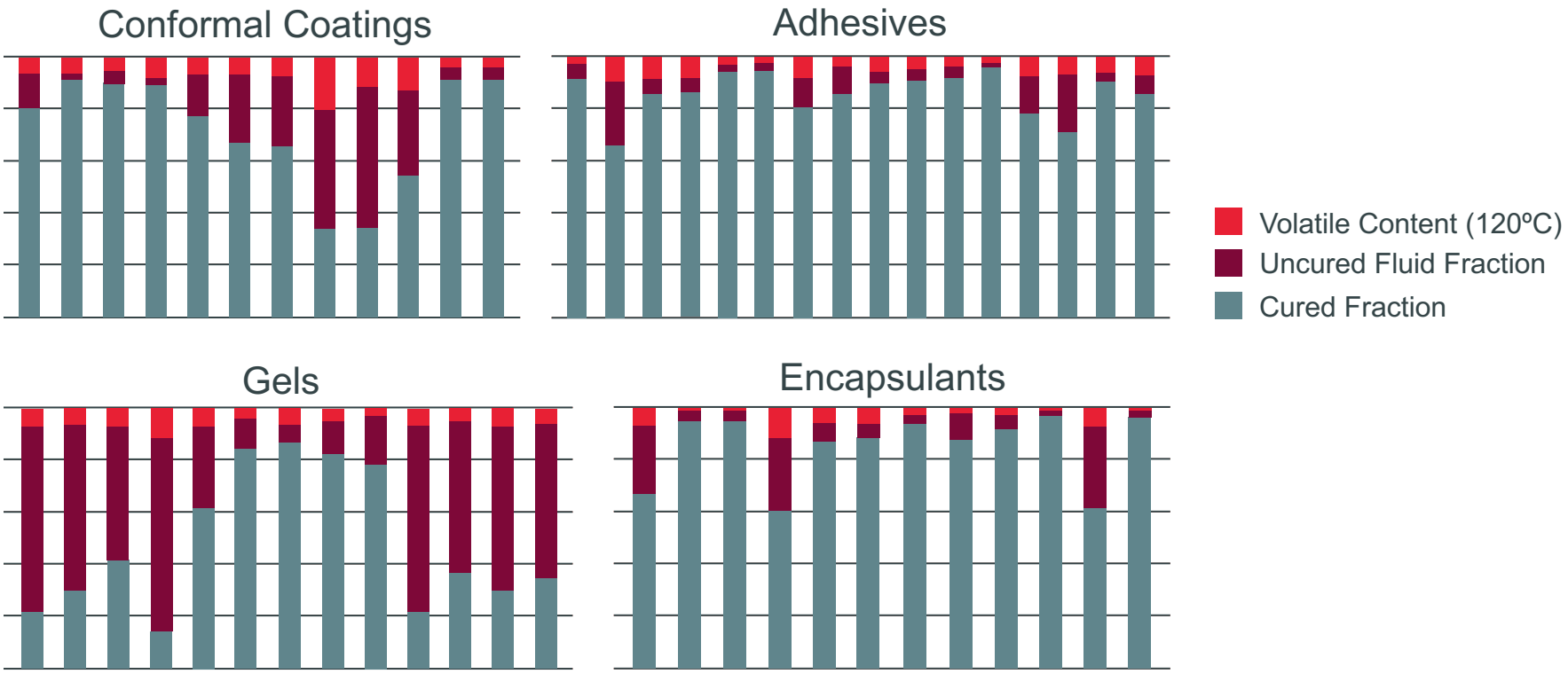
Methods to Reduce Volatile Content

- Strip volatile linears/cyclics out of **polymers** – all Silicone manufactures
  - Silicone volatiles are inevitable because of incomplete polymerization and capping
- Strip **fully formulated** material - 125˚C and $1x10^{-6}$ torr
  - Will evaporate **crosslinker, adhesion promoter, working time additives**, and any volatile linears/cyclics
- Strip a **cured sample** - 125˚C and $1x10^{-6}$ torr
  - Takes up to 1 week to complete depending on final part design
  - Difficult to know when process has completed

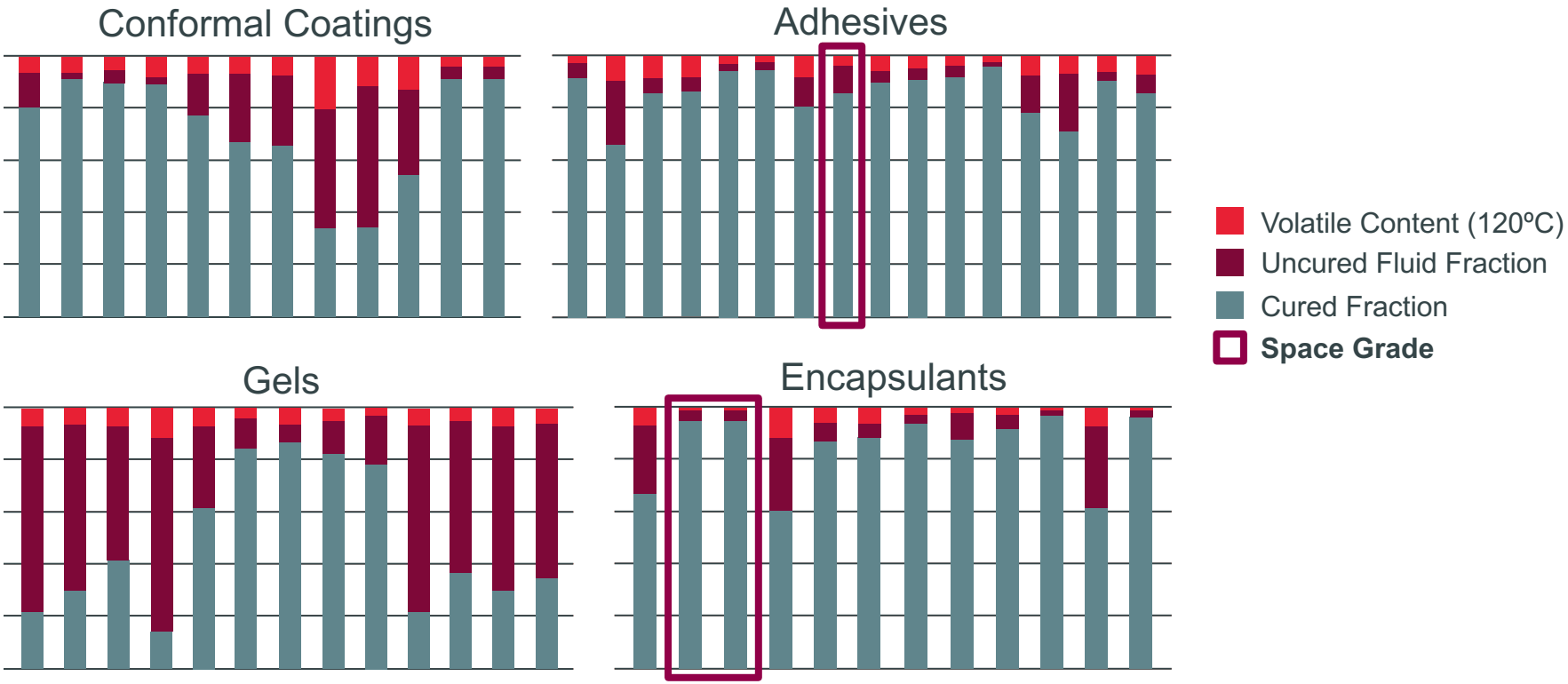
- **First and third methods** proven to produce **identical** fully cured **properties**
  - 1”x2”x0.25” sample



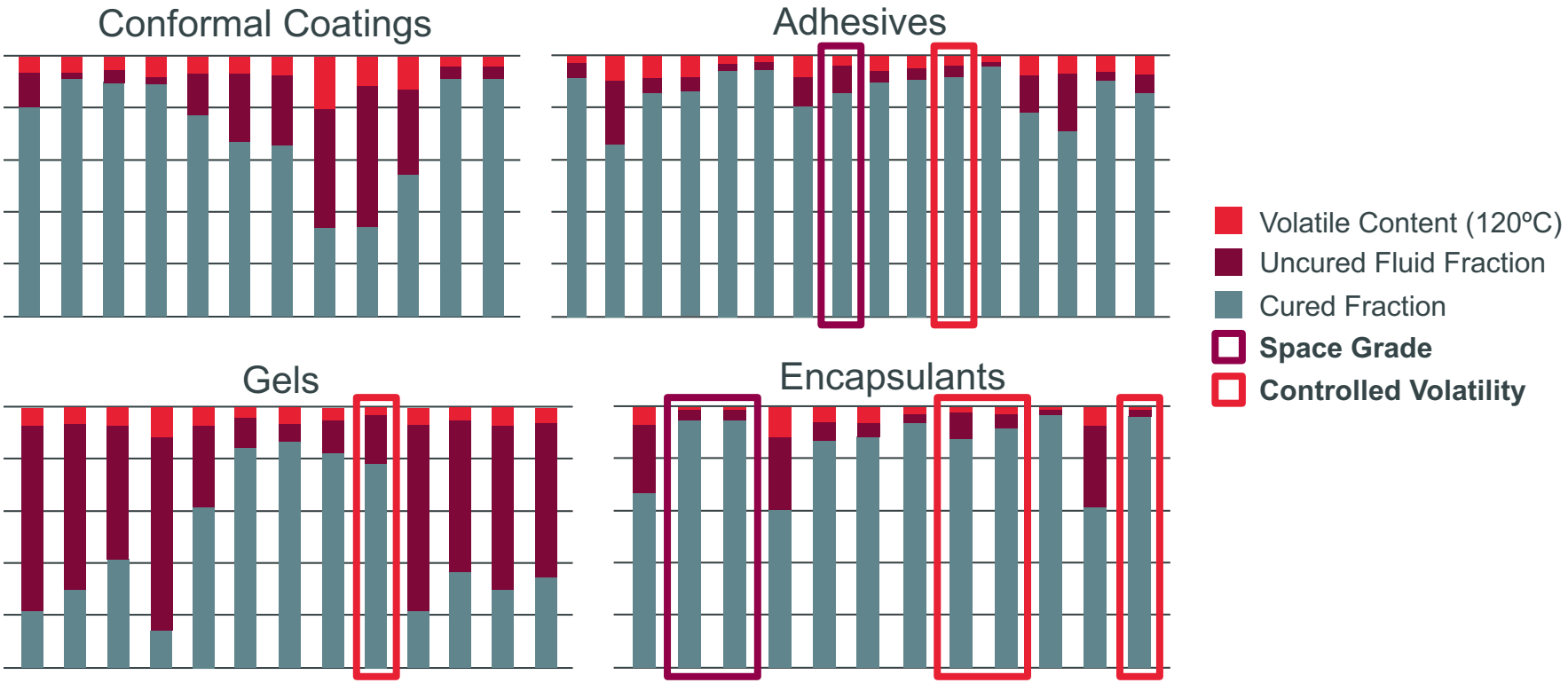
Volatile/Liquid Content in DOWSIL™ Silicones



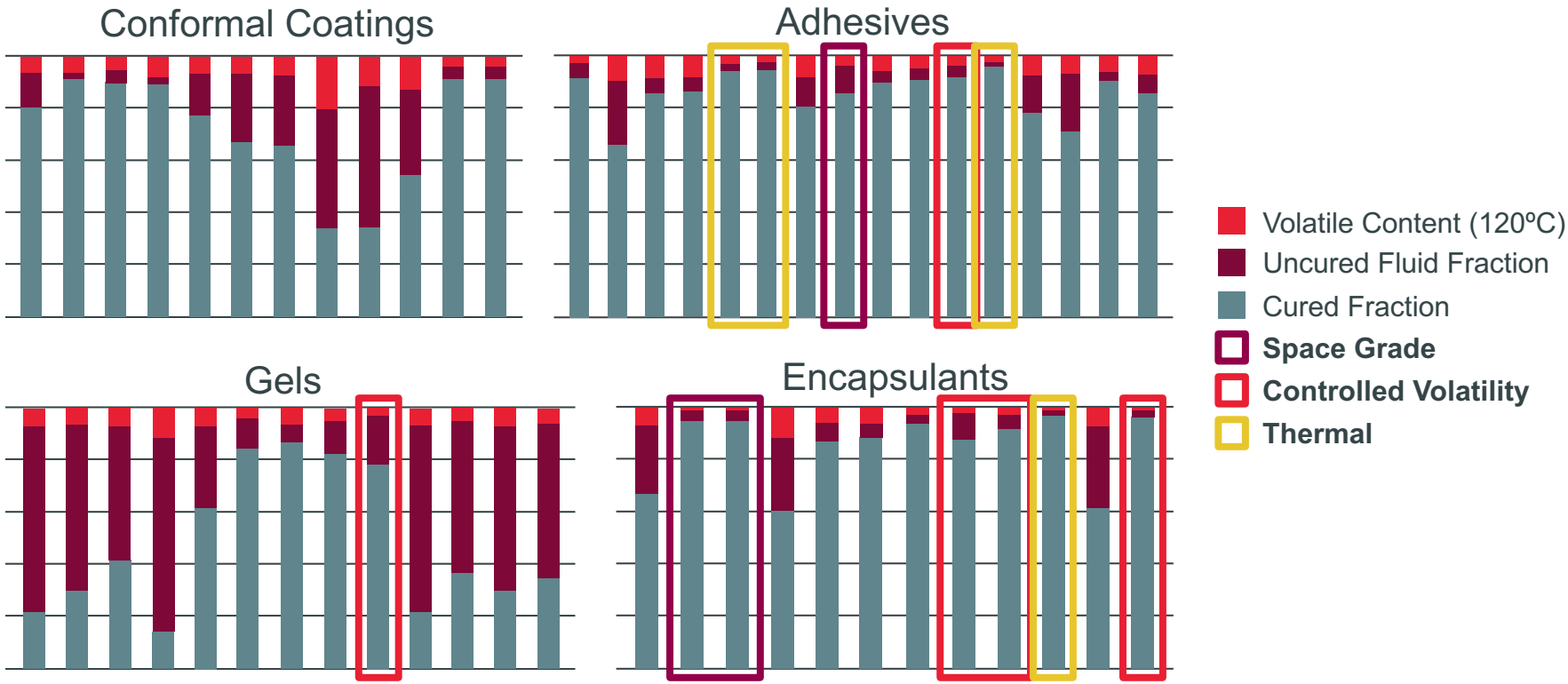
Volatile/Liquid Content in DOWSIL™ Silicones



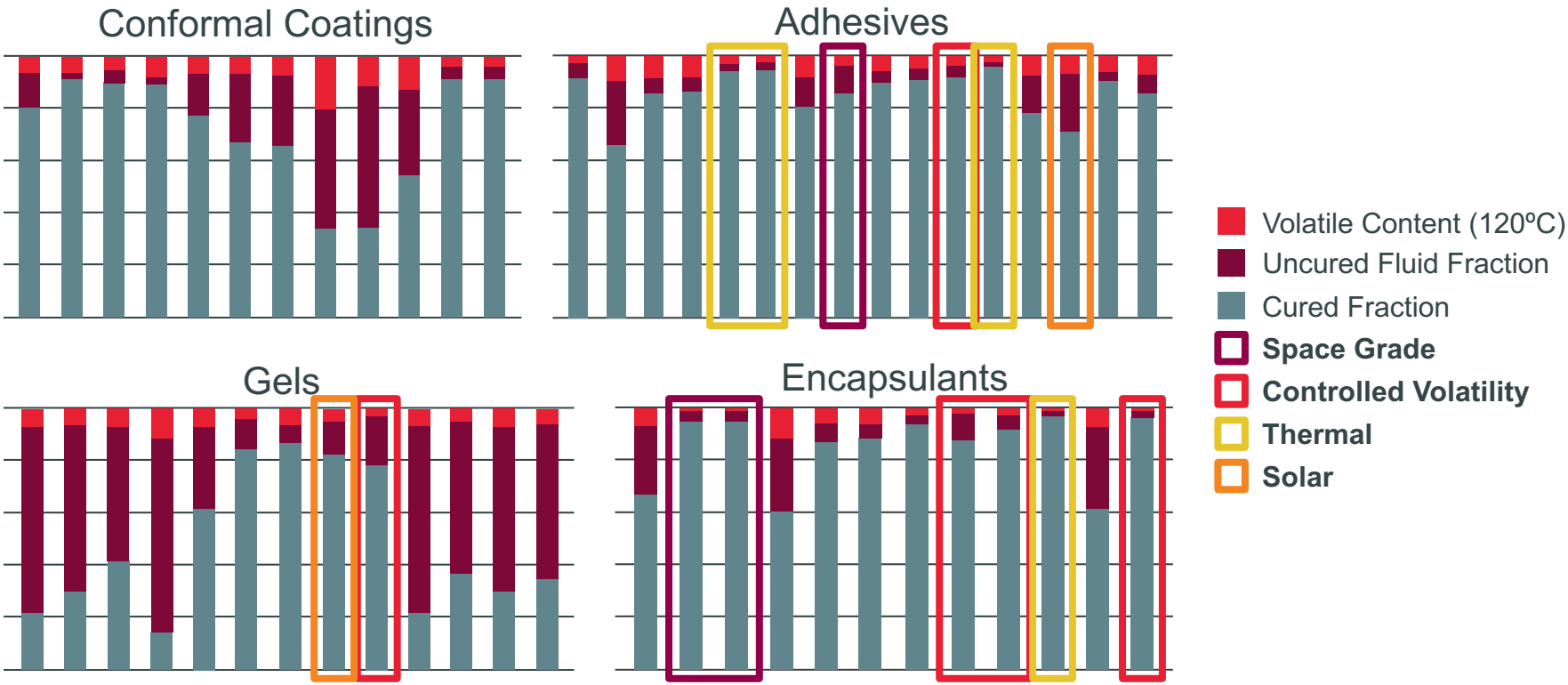
Volatile/Liquid Content in DOWSIL™ Silicones



Volatile/Liquid Content in DOWSIL™ Silicones



Volatile/Liquid Content in DOWSIL™ Silicones



Summary

- Silicones have advantages properties for **extreme environments**
  - Thermal stability, UV stability, easy processing, moisture resistance, repairable
- Silicones need **special processing** to achieve stability in **high vacuum**
  - Incomplete polymerization and capping
- Can strip the **polymers**, uncured **fully formulated**, or fully **cured samples**
  - Takes time, risk of evaporating important components, can be expensive
- **Space grade** materials have the **lowest volatile** content; only **high MW**
  - Other materials could work in space depending on the application

Thank You

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New Brand Name.

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silicones by DOW