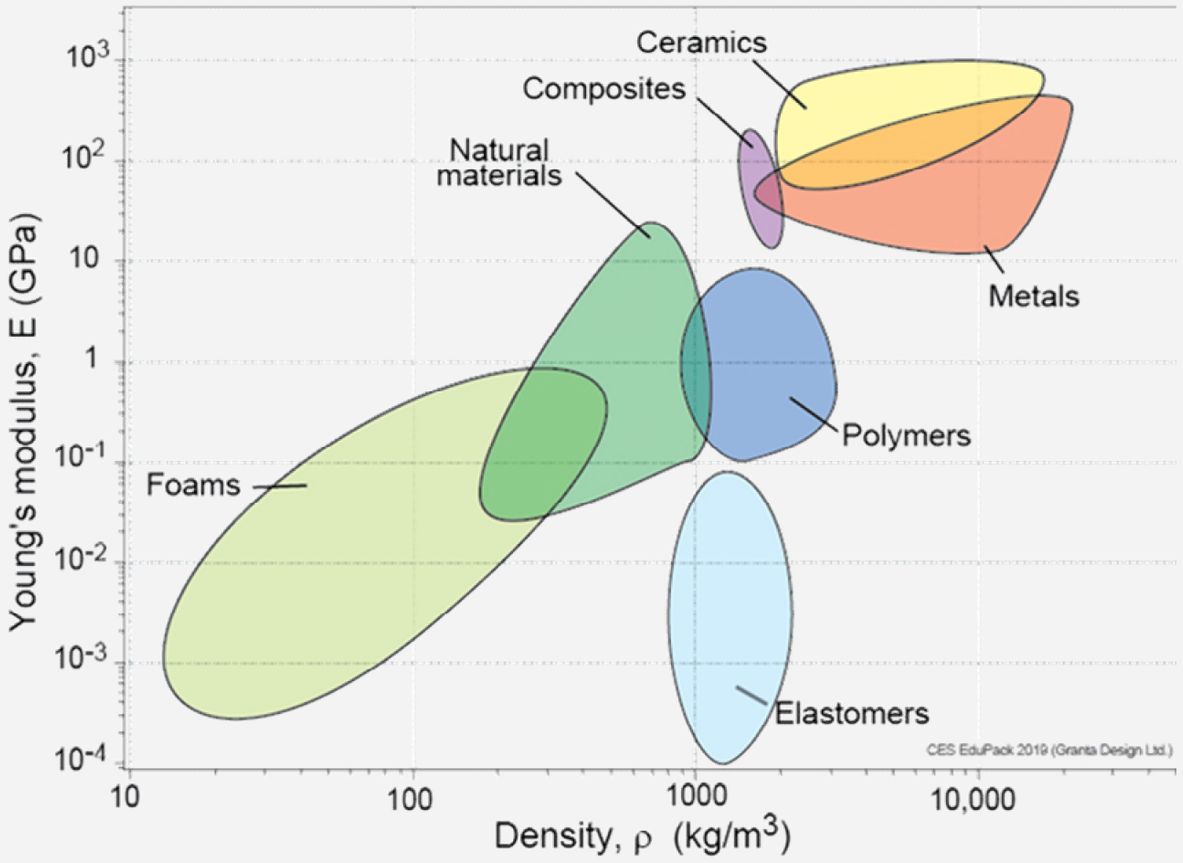
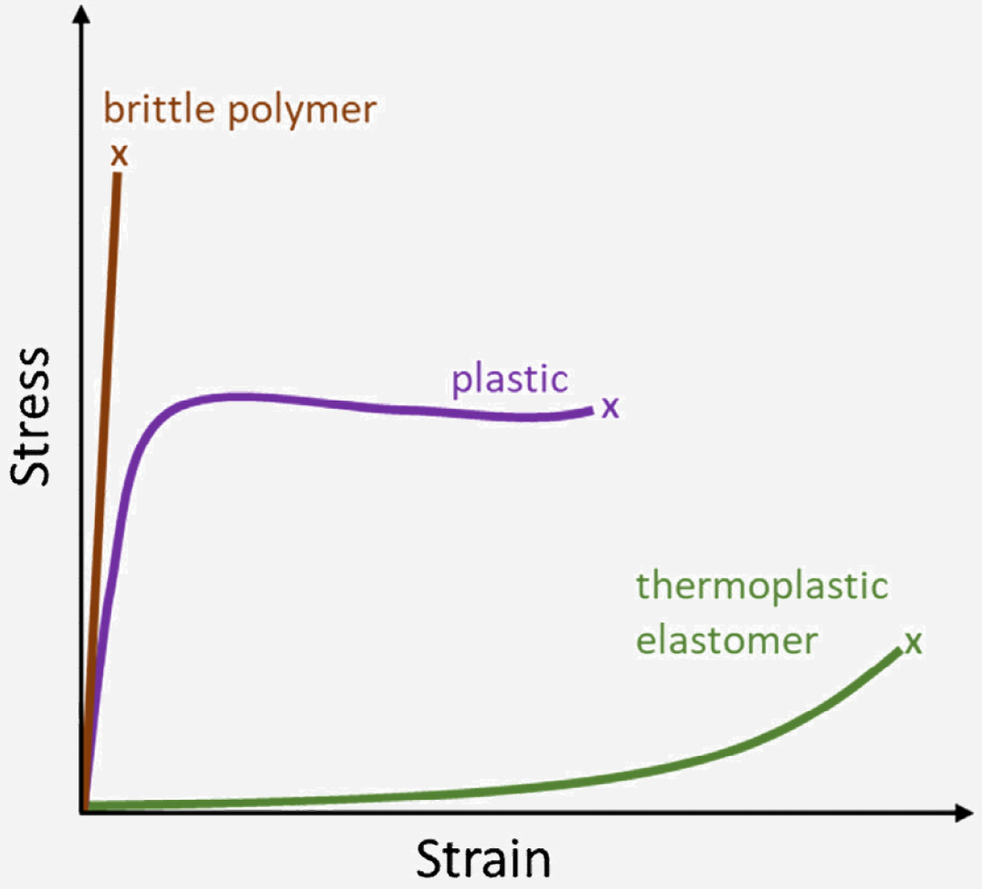
3d printing elastomers – the future?

Dr Sarah Karmel
Head of Chemistry
Rheon Labs

- Elastic polymers

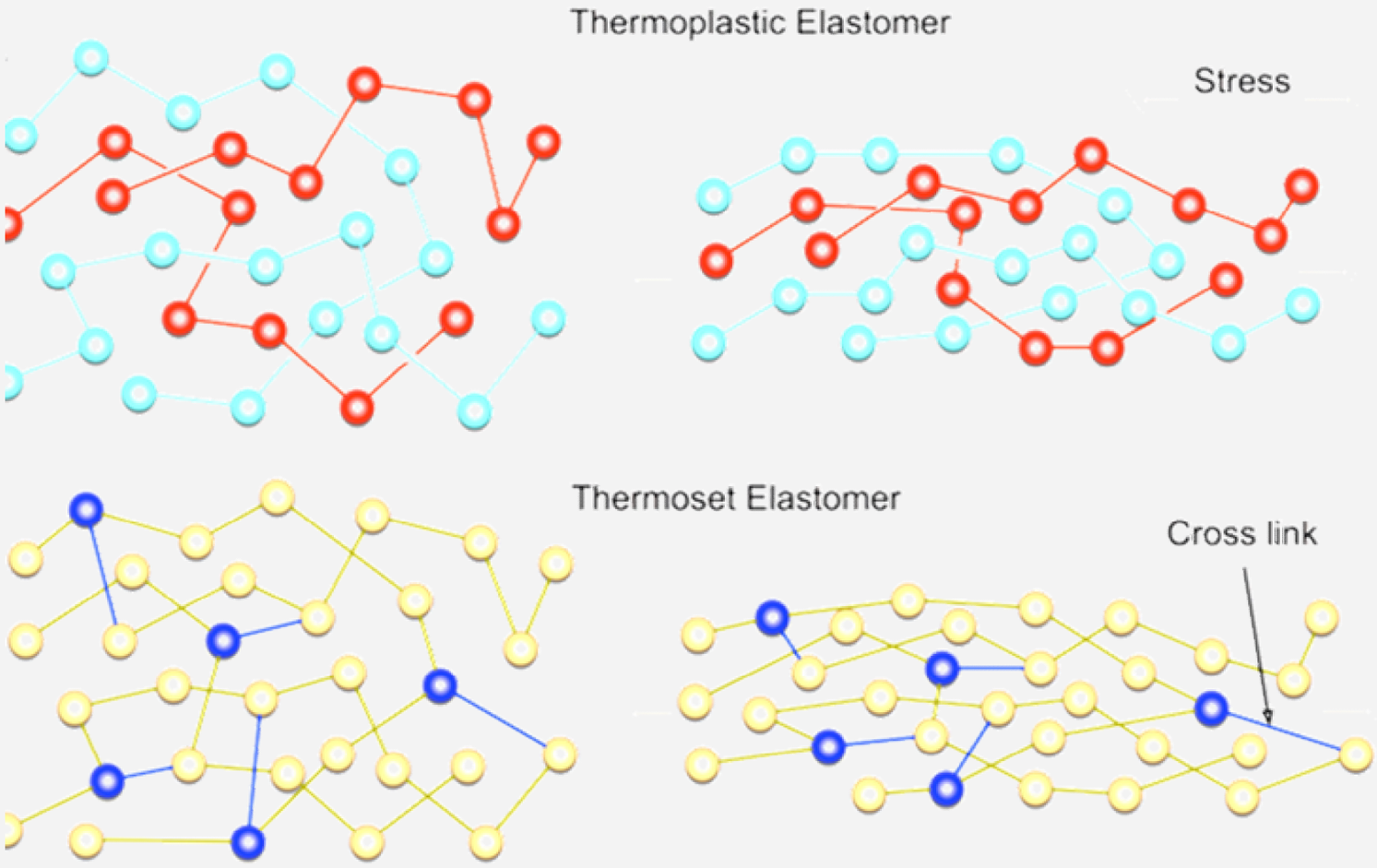




WHAT ARE ELASTOMERS?

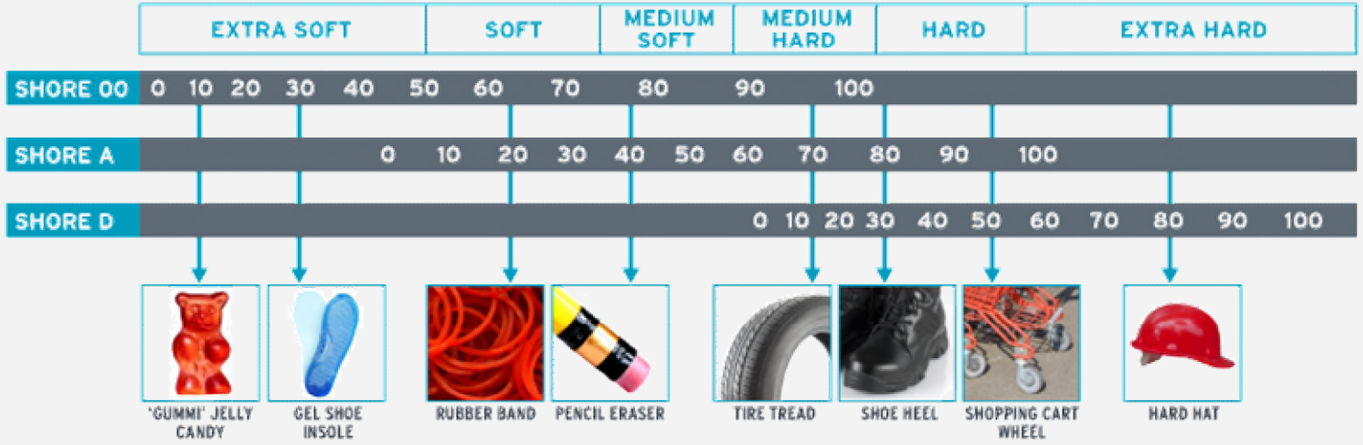
THERMOPLASTIC VS THERMOSET ELASTOMERS

- Long polymer chains
- Undergo shape recovery after being submitted to strain



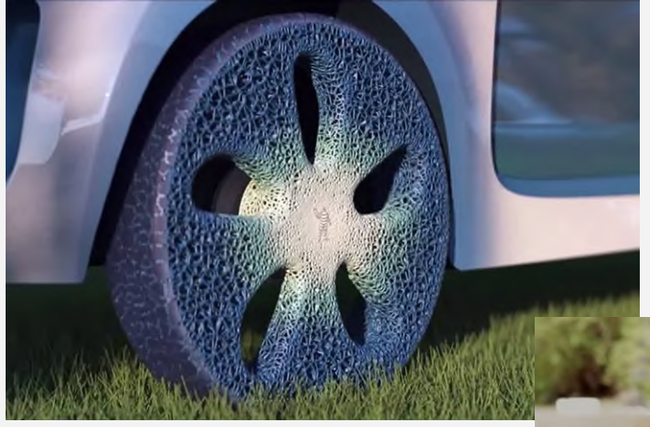
WHAT ARE ELASTOMERS USED FOR?

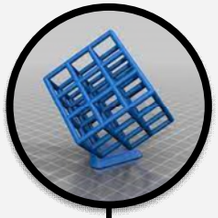
SHORE HARDNESS SCALES



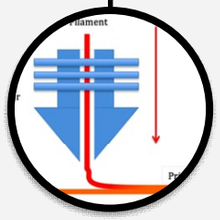
WHY 3D PRINT ELASTOMERS?

- Data driven design
- Personalization
- Lower density / weight structures
- On demand parts
- Low material waste (AM)

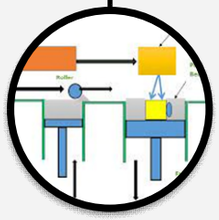




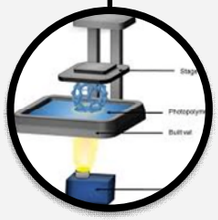
Additive Manufacturing



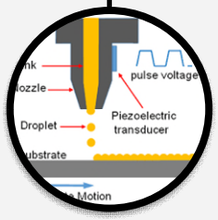
FFF



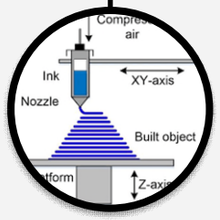
SLS



SLA



Inkjet



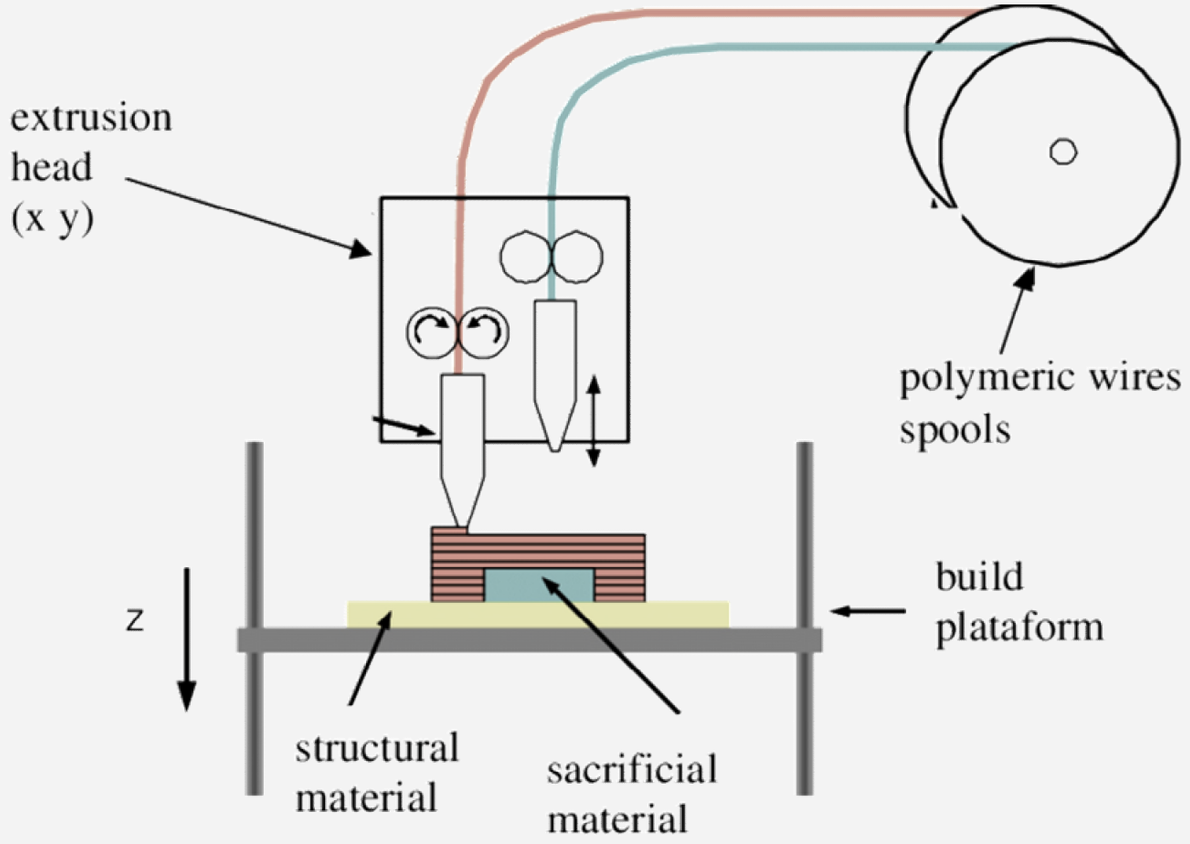
DIW

Thermoplastic elastomers

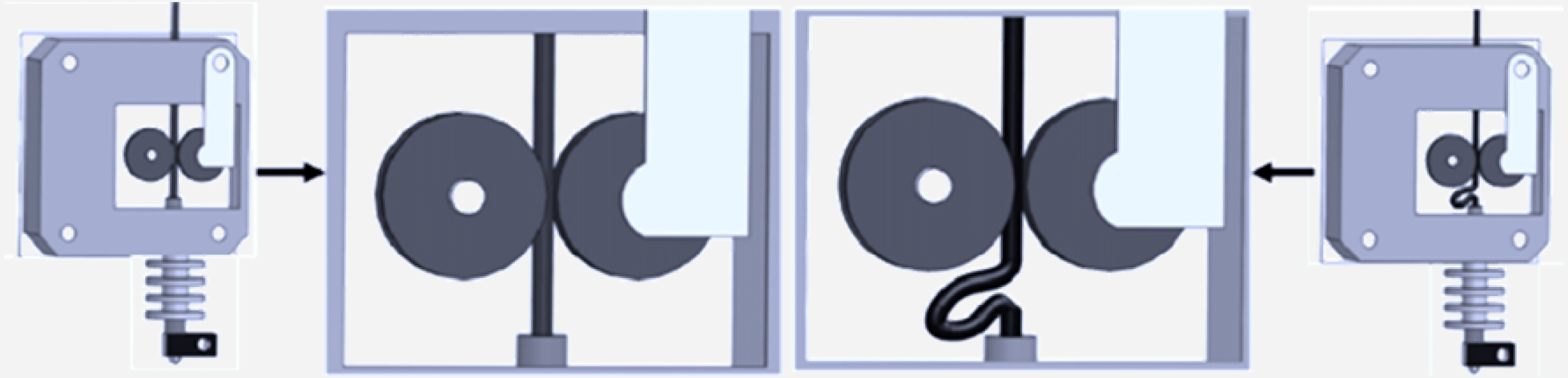
Thermoset elastomers

3D PRINTING OF THERMOPLASTIC ELASTOMERS: FUSED FILAMENT FABRICATION (FFF)

- Poor interlayer adhesion
- Poor mechanical properties in parts
- Poor surface finish
- Hygroscopicity of elastomeric filaments



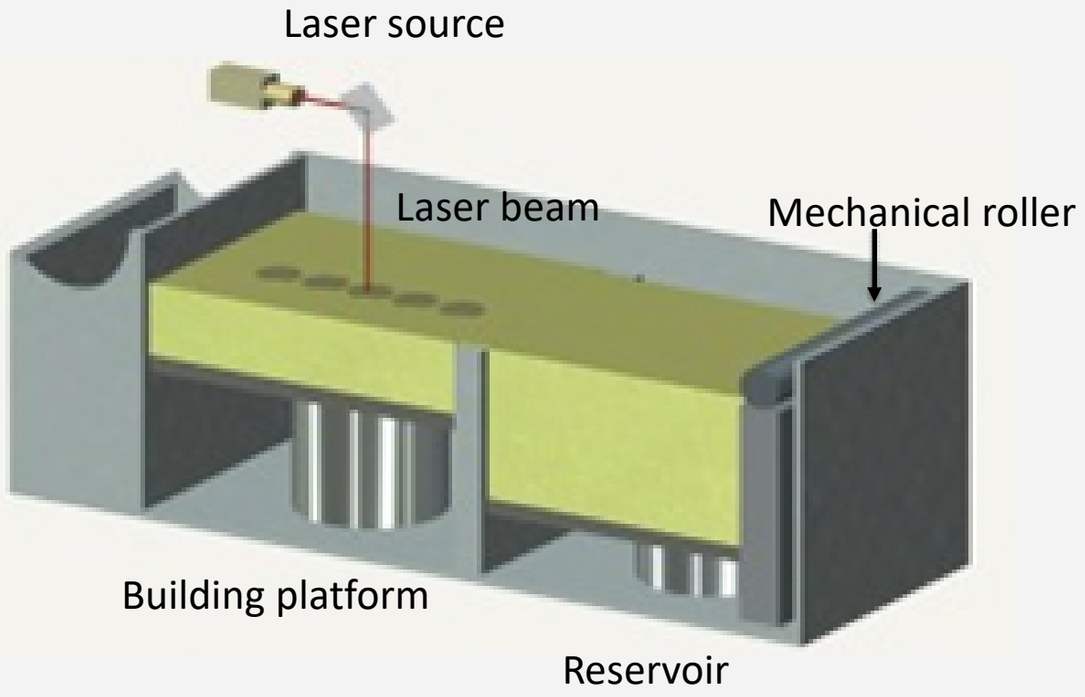
- Low Modulus of elastomeric filament → filament buckling



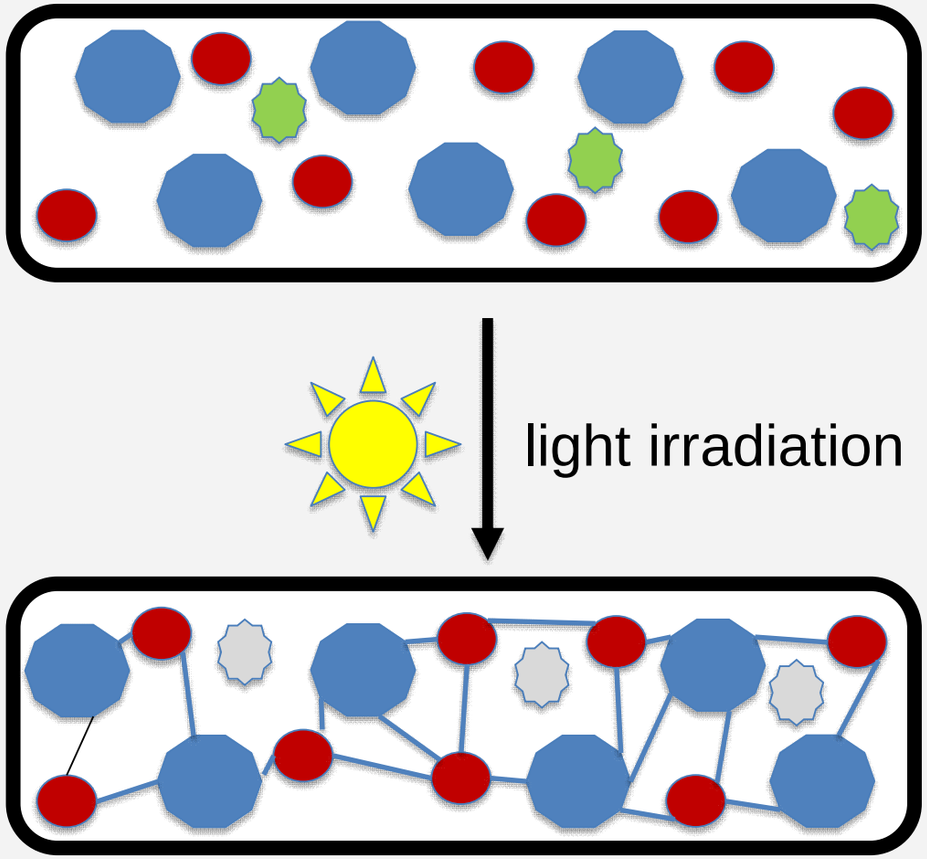
High EMod → no buckling Low EMod → buckling

3D PRINTING OF THERMOPLASTIC ELASTOMERS: SELECTIVE LASER SINTERING (SLS)

- Use of spherical powders
- Well-defined powder diameter required
- Challenging powder preparation
- Cryo-milling or solvent precipitation: compatibility with elastomers
- Currently: limited material availability



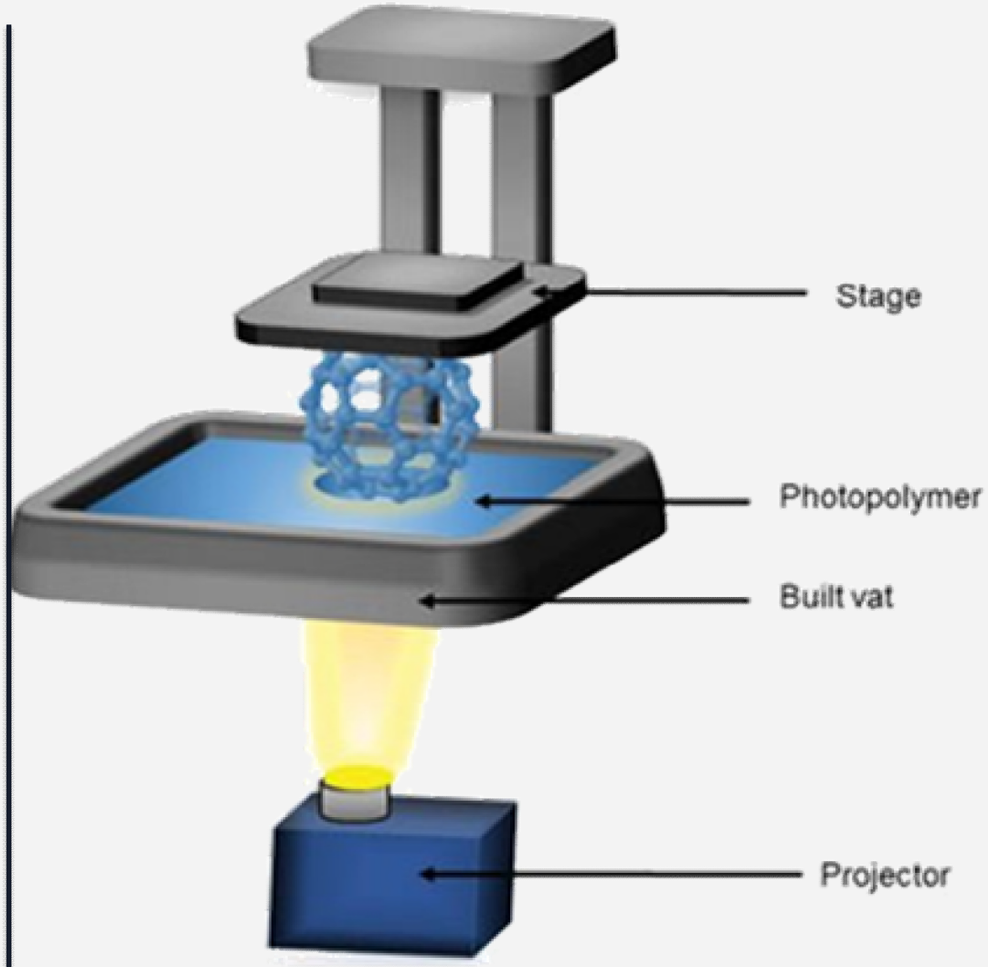
3D PRINTING OF THERMOSET ELASTOMERS: VAT PHOTOPOLYMERIZATION



Monomer

Oligomer

Photoinitiator

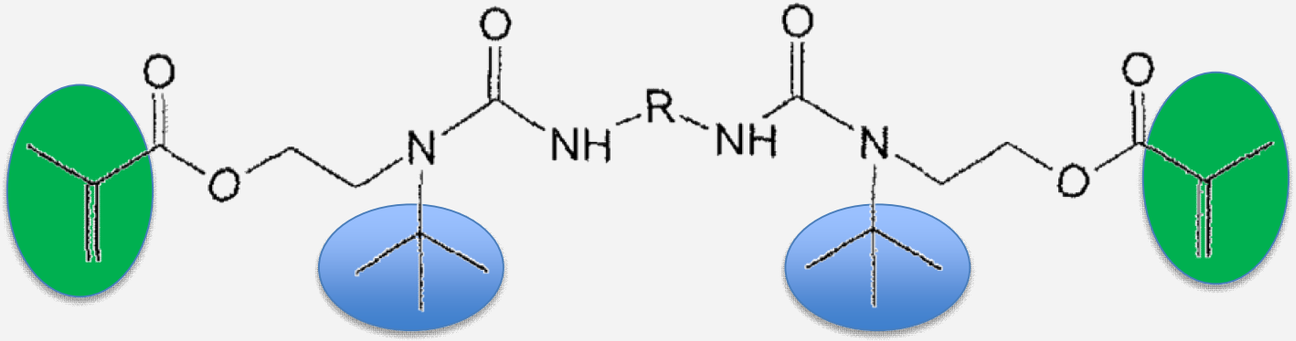


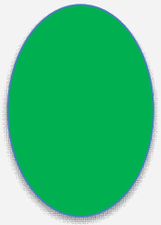
3D PRINTING OF THERMOSET ELASTOMERS: VAT PHOTOPOLYMERIZATION

- Polymer chain length is key to mechanical properties
- Vat photopolymerization is limited by viscosity
- Addition of (meth)acrylate monomers to achieve printable viscosities
- Loss of properties
- Introduction of brittleness

Innovative solutions: Carbon 3d secondary chain extension

- Use of 2-component systems





Radically polymerizable methacrylate function

Thermally labile bond

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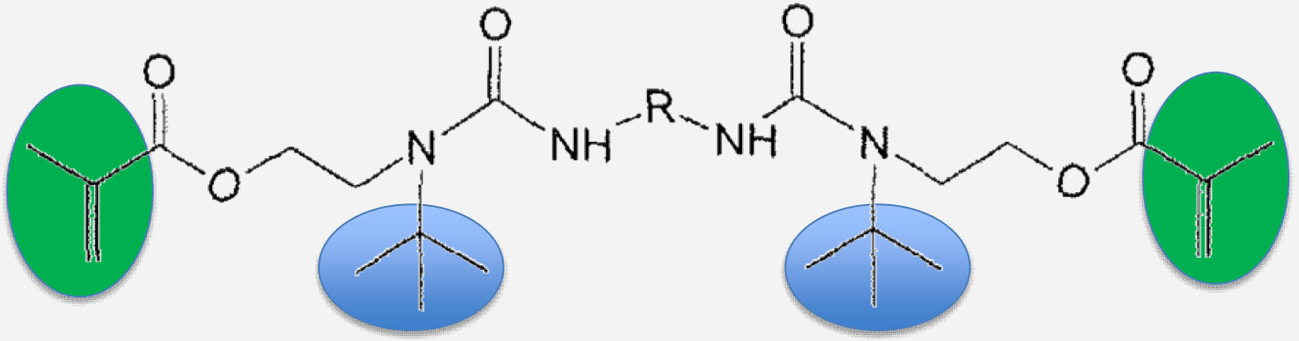
Innovative solutions: Carbon 3d secondary chain extension

- Use of 2-component systems



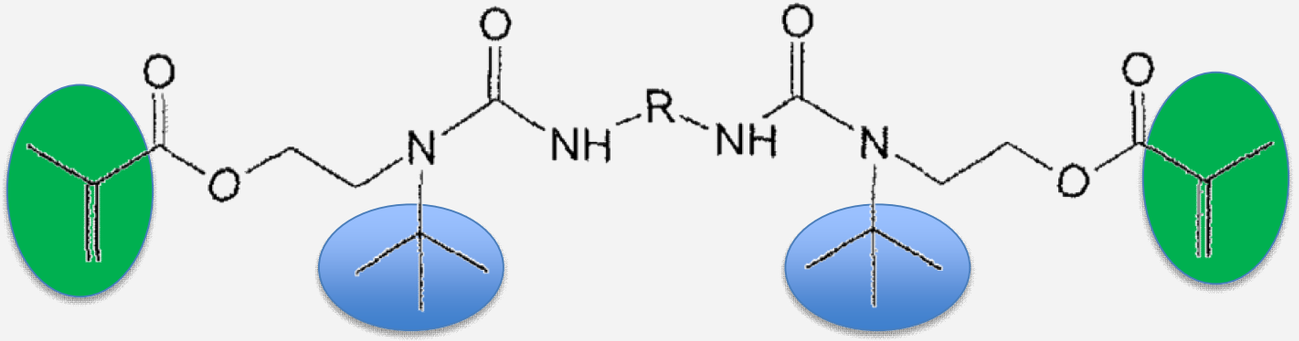
Step 1: radical polymerization

Step 2: thermal annealing

Step 3: chain extension with R-OH or similar

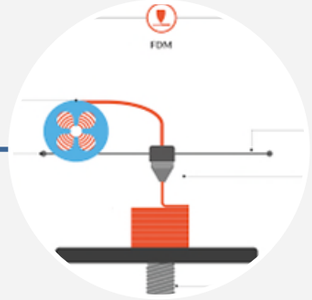
Innovative solutions: Carbon 3d secondary chain extension

- Use of 2-component systems

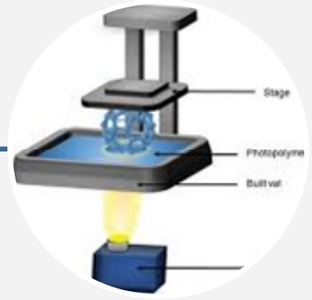


- Long polymer chains with true elastomeric properties

AM of elastomers



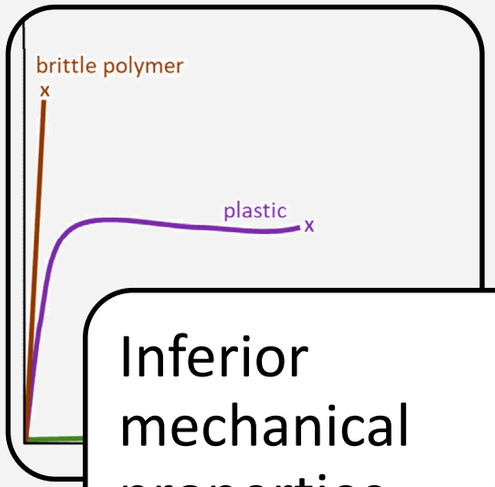
Thermoplastics



Thermosets

Innovation in the field

3D PRINTING OF THERMOPLASTIC ELASTOMERS: THE CHALLENGE



Inferior mechanical properties

- Acrylate bonds
- Interlayer adhesion

High cost per part

- Material cost
- Processing costs

Production time

- Slow printing process
- Long post processing

3d printing of high-performance elastomers

Our Vision

Our vision is to empower performance through our technology.

We are driven to engineer products with our partners which deliver truly game-changing performance in energy control.

IMAGE: NFL AND SEATTLE SEAHAWKS ATHLETE JOSH GORDON WEARING THE XENITH X RHEON SHADOW XR HELMET

REACTIVE POLYMERS

- At the core of RHEON™ technology is a **reactive polymer** that **intelligently strengthens** when subjected to force.

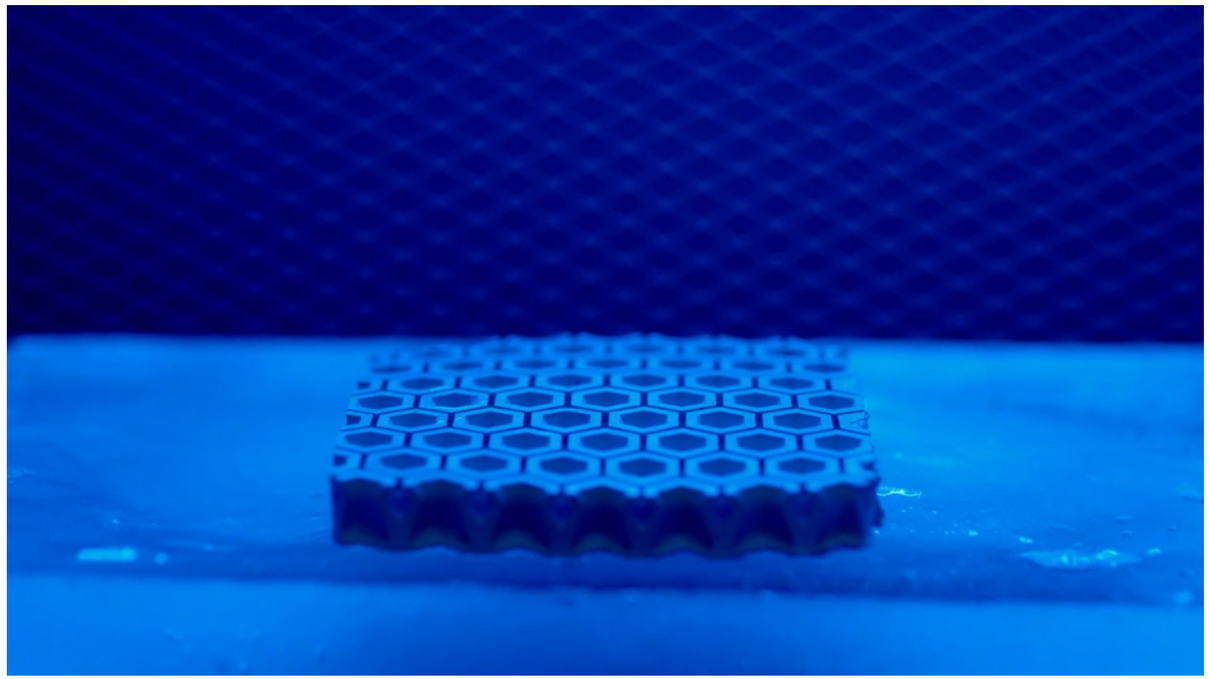
- RHEON LABS can make adjustments to the material chemistry to achieve different product feel and performance.

RHEON™ TECHNOLOGY

RHEON™ technology can **control energy** of any amplitude or frequency – from small vibrations to life-threatening single impacts.

At the core of RHEON™ technology is **reactive polymer** that intelligently strengthens when subjected to force.

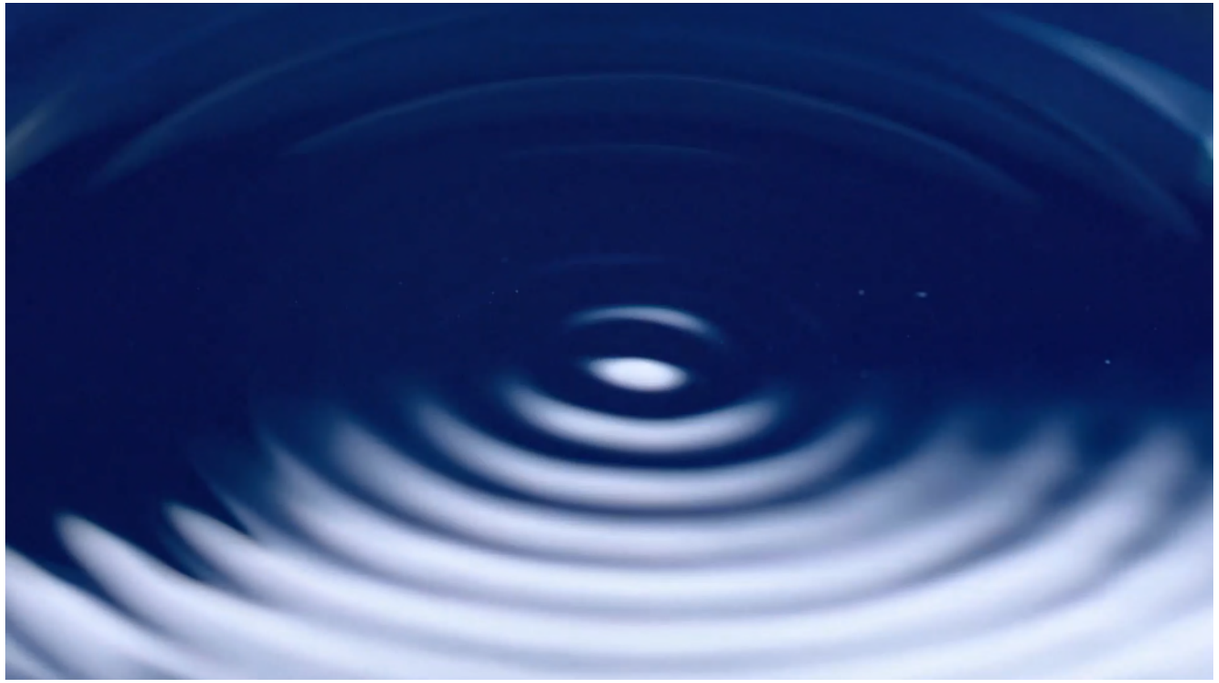
RHEON™ technology is **soft and flexible** in its natural state but stiffens momentarily to dissipate high levels of energy.



IMPACT CONTROL

- RHEON™ technology **dynamically dissipates energy**.

- This dynamic property provides a breakthrough for applications where **flexibility and movement** are paramount but high levels of impact dissipation are a must.



VIBRATION CONTROL

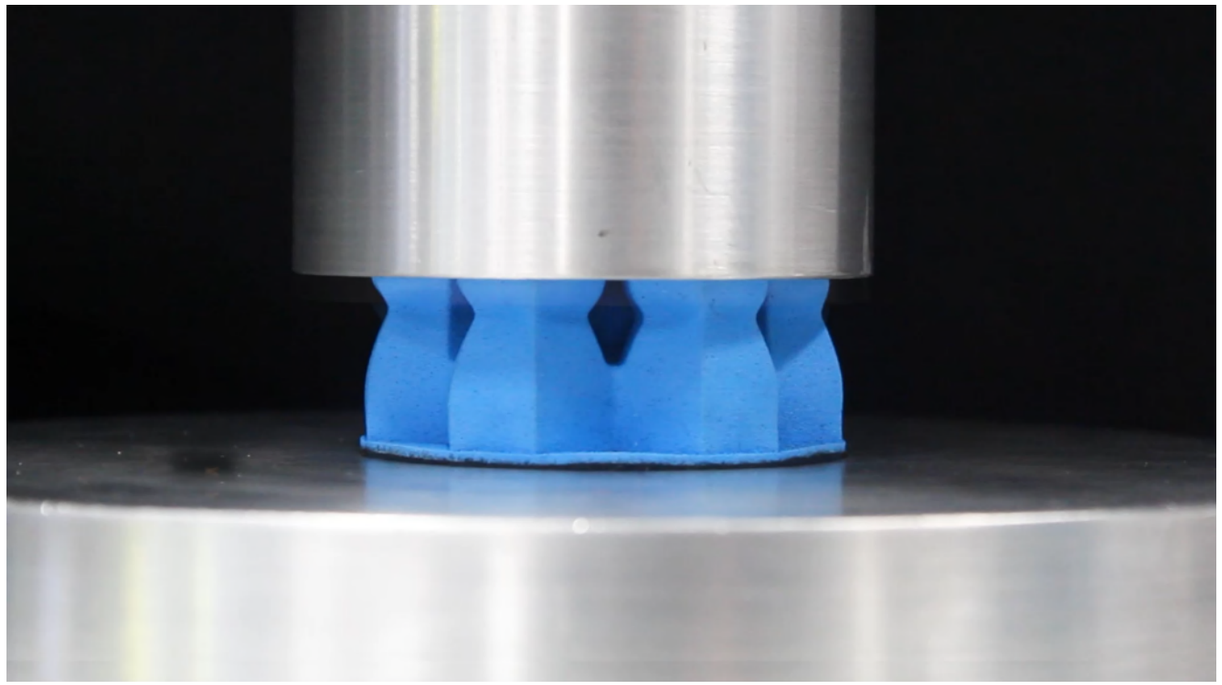
- RHEON™ technology **actively dampens vibration** and noise.
- The technology reacts to control small vibrations or constant noise for **enhanced comfort and performance**.
- A game-changer for any application where reducing vibration is key to product performance.

FUNCTIONAL GEOMETRIES

- RHEON™ geometries can be used to drive the density, feel and performance of your product.

- They can be designed to give what we call **anisotropic performance.**

- This unique design feature allows products to have **different properties** depending on the direction or force it they are subjected to.

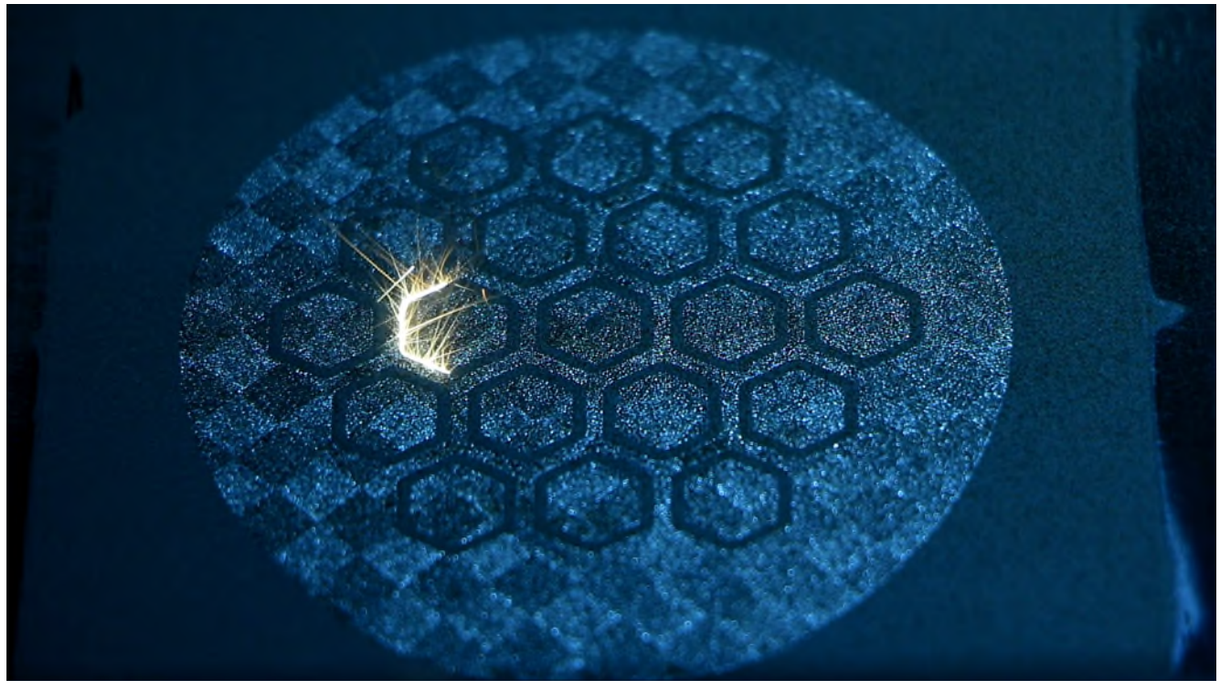


ADVANCED MANUFACTURING

- RHEON uses a combination of advanced manufacturing techniques to **rapidly scale up solutions**.

- Such techniques rapidly cut down the time from concept to production.

- The RHEON™ technology platform allows engineers and designers to fundamentally **re-imagine their products**, to **iterate faster** and deliver product properties previously thought impossible with conventional materials.



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