MATERIALS WEEK EUROPE

The next speaker is...

Dr Daniel Chen
CTO
Neopara Materials

Waste Not, Want Not: Derived Reinforcing Fillers Shrink the Carbon Footprint of Silicones

Neopara MATERIALS

Scan below for Conference Agenda

MATERIALS WEEK EUROPE

Feb. 24-26, 2026

Neopara MATERIALS

BOOTH 736

Waste Not, Want Not: Waste-Derived Reinforcing Fillers Shrink the Carbon Footprint of Silicones

Yang Chen* and Michael A. Brook

Daniel Chen, PhD

Chief Technology Officer

20+ years in organic and polymer synthesis, 25+ R&D projects, 53 papers, and holds 12 patents

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Michael A. Brook, PhD

Chief Scientific Officer

Faculty of Science Chair in Sustainable Silicone Polymers at McMaster U, 315+ papers, 12 patents, numerous awards

mike@neoparaco.com

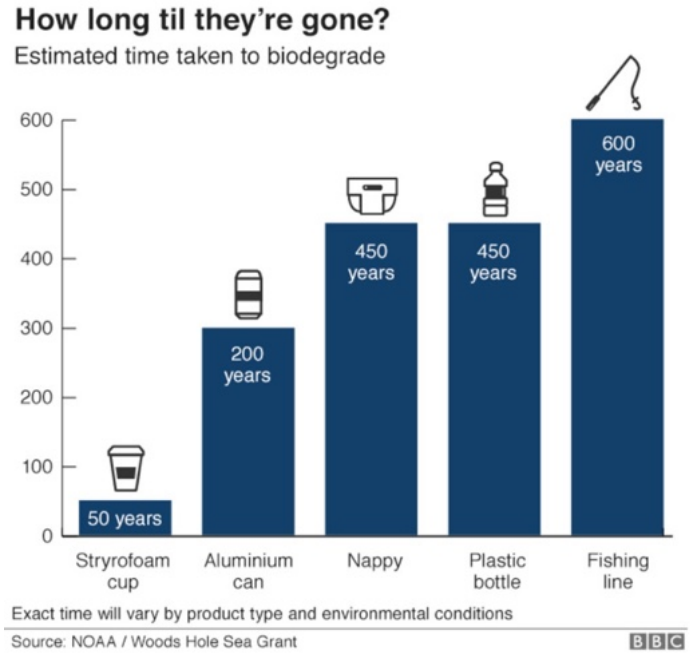
Ancient Garbage Dumps (Middens) Show Valuable Treasures

Shell **midden** Santa Cruz, Argentina

https://en.wikipedia.org/wiki/Midden

https://news.uchicago.edu/story/archaeologist-talks-trash

Landfills – Not So Much: Environmental Degradation is Slow



These are aerobic conditions; Anaerobic degradation rates in landfills are worse (40 year old hot dogs)

https://www.bbc.com/news/world-us-canada-48477087

Waste Not - Want Not: Waste Can Be Treasure

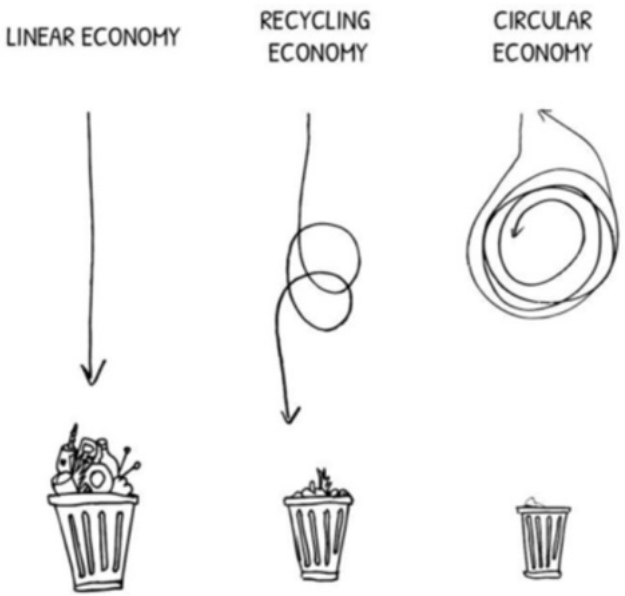
Rubber crumb 200-250 microns

Tire Fluff (PET, nylon)

GGP
< 4 microns

Our Starting Materials for the Circular Economy

Circular Economy



Where are we?

Why Are Silicone Elastomers Attractive?

Surface active

Foam, Defoamer

Electrical Resistance

Spark plug wires

Photostability

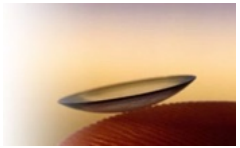
LED Domes

Biological Compatibility

Food Contact

Baby Teat

Topical



Contact lenses

Internal

Pacemaker leads

Low Surface Energy

Waterproof, Creeps on Surfaces

Adhesives and Sealants

Thermal stability

Air bag Coatings

The Silicone Life Cycle and Sustainability: Waste

DEGRADE

DILUTE

Add Waste Here

Neopara MATERIALS

Turning waste into effective reinforcing fillers

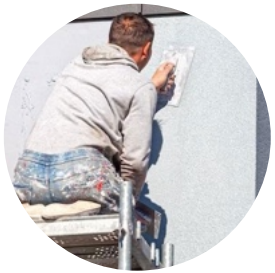
Waste Not, Want Not

Silicones are the GOLD STANDARD for Construction Sealants; Adhesives; Coatings: **a ~$9B market**

Outside sealants

Roof coatings

Expansion joints



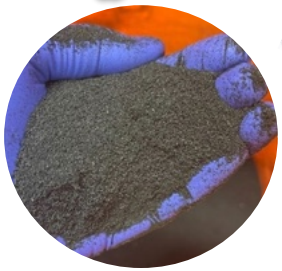
Wall/masonry coatings

10

Neopara **HPP** in Sealants

Grind,

coating



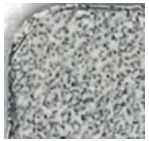
HPP
High Performance Particles

Neopara MATERIALS

Commercial Sealant

In clear

In tan

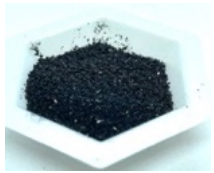


Zoom shows ‘salt/pepper’

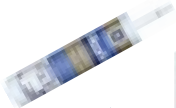
In white

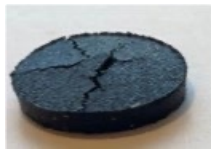
w/ thin coat white silicone

Excellent adhesion



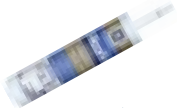
Unmodified rubber





Fail

HPP

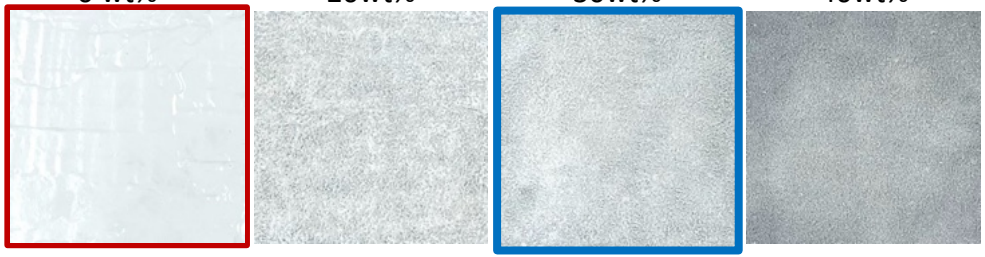


PASS

Neopara **HPP** in Roof, Wall and Floor Coatings

COMMERCIAL ROOF COATING

0 wt% | 20wt% | 30wt% | 40wt%



Small particles (<250 micron)

Tint-able using traditional pigments

30wt% | 30wt% | 30wt%

TINTED WHITE

Small particles (<250 micron)

TINTED YELLOW

<250 micron

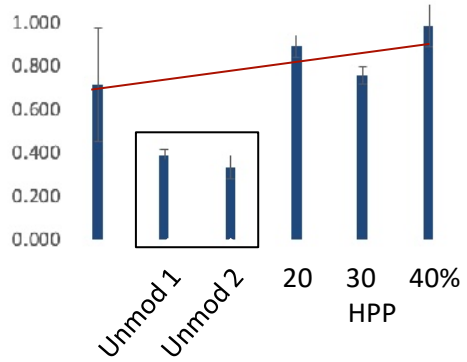
<250 micron

Big particles (~2500 micron)

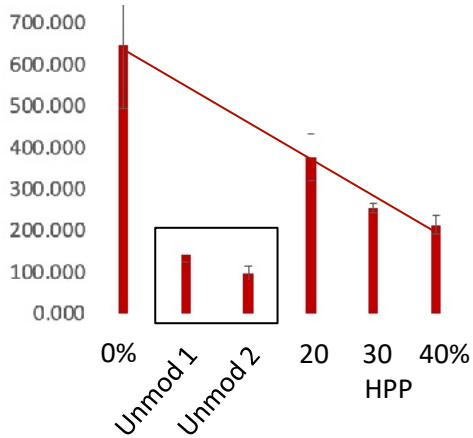
ZOOM

Physical Properties: **HPP** Are Reinforcing Fillers

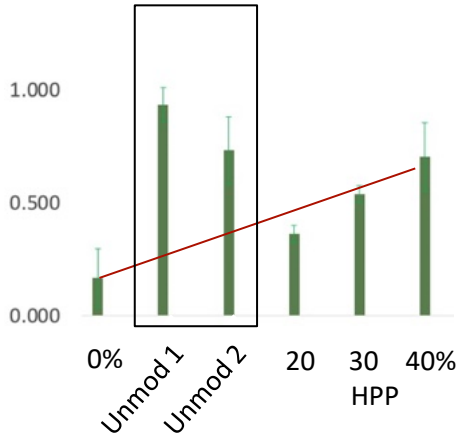
Tensile Strength, (MPa)



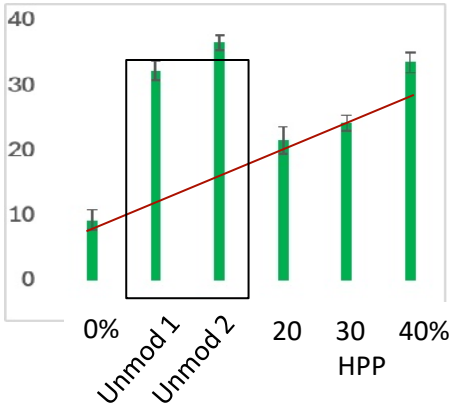
Elongation at Break (%)



Young's modulus, (MPa)



Shore A hardness

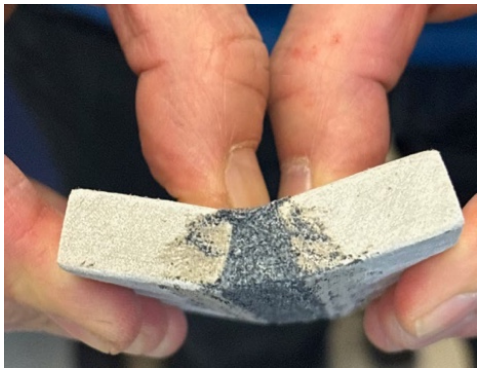


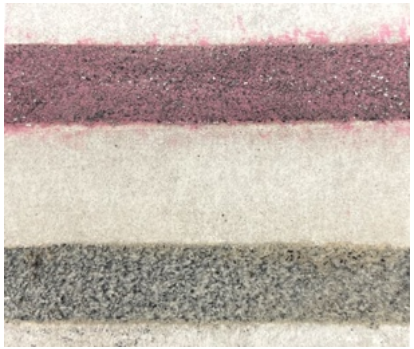
ASTM-D412 **PASS**, ASTM-D2240 **PASS**

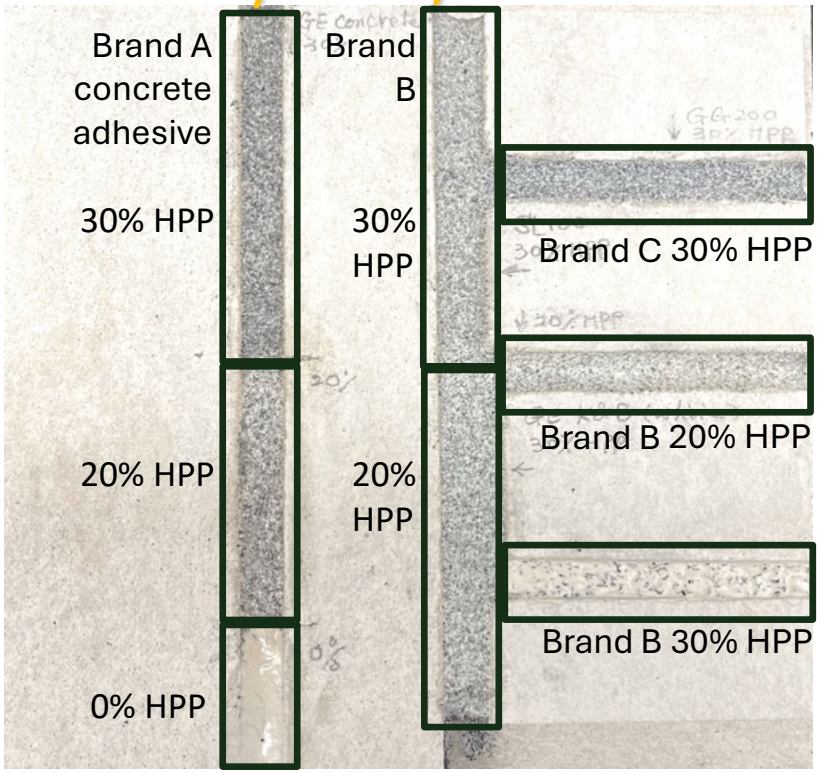
Trend lines show ~ linear increase with %filler; Unmodified GTR (in boxes) is a non-reinforcing filler

Neopara **HPP** in Adhesives

Concrete (1/2”) adhesion bead





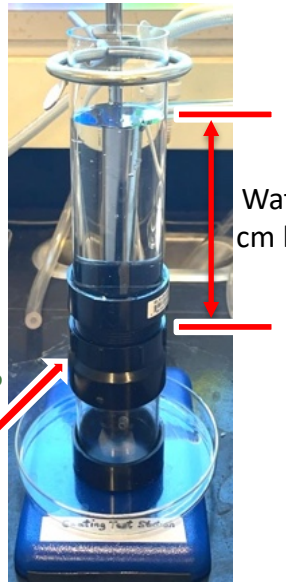


Performance Against Requirements

Waterproof Test for Roofing - **PASS**

ASTM 7281 equivalent

6- inch head of water, 30 days

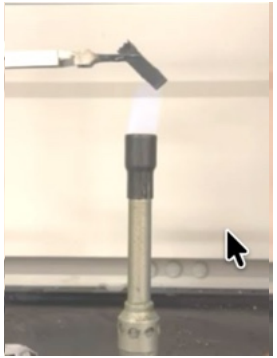


Flammability Test - **PASS**

UL-94V equivalent

Time 30 s

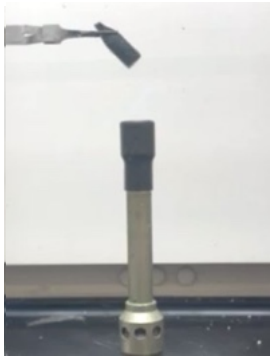
Tire Rubber



1st ignition

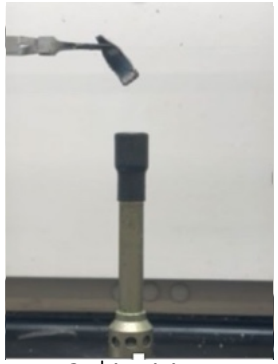
Video link
https://youtu.be/bWyHFujkTEM

30% HPP



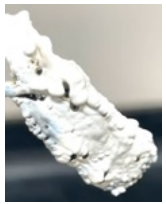
1st ignition

Video link
https://youtu.be/HRn51QxLELQ

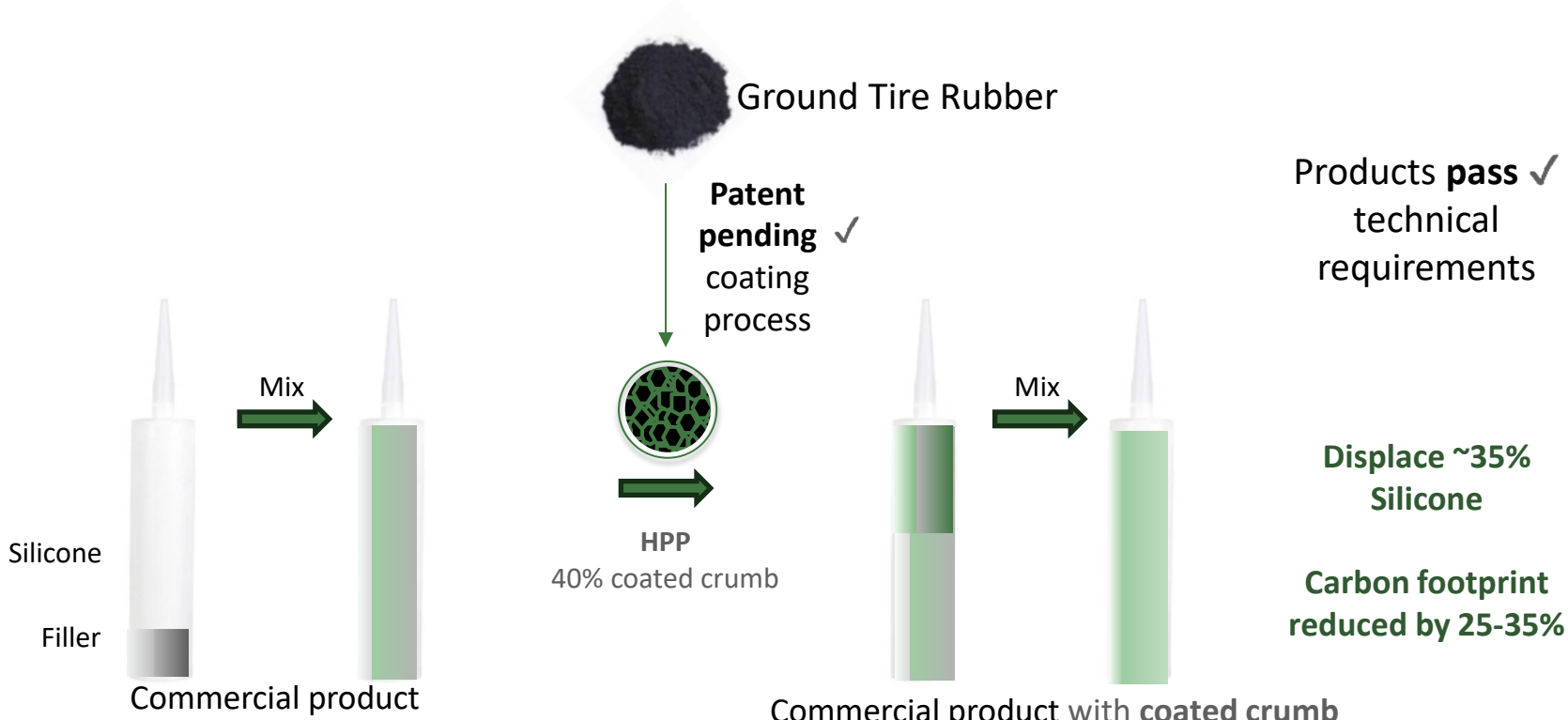


2nd ignition

Video link
https://youtu.be/PmA1wRs8CoI



Silica shell



Can We Overcome the 50 weight% Limit: Compression Molding

25 x 76 mm

156 - 170 g

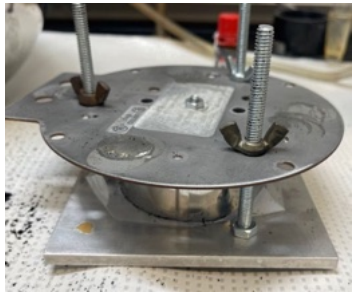
Density = 1.43

Often with a skin and a logo

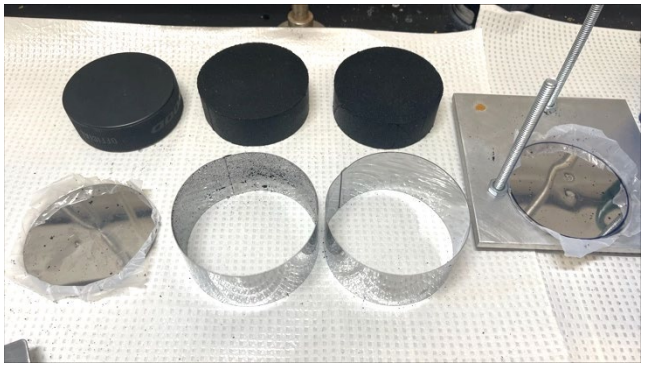
80 wt%
HPP

RTV silicone 20%
Simple mixing

1-10 ton pressure

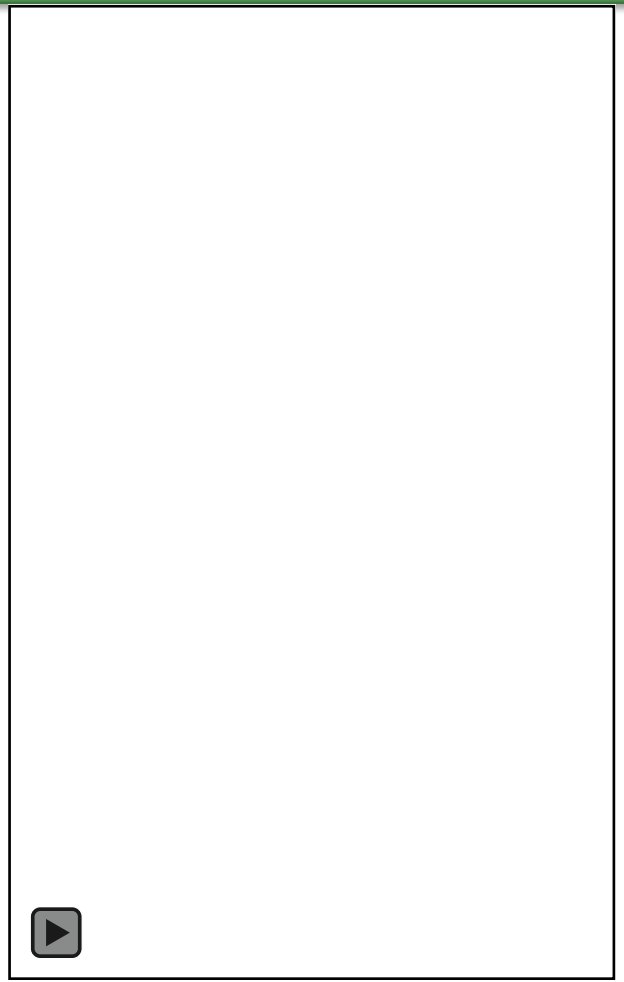


- Silicone migrates to the surface during curing.
- As a result, the part surfaces become siliconized.
- No mold release agent required



Simple molds
Crumb 200-250 micron
Won't enter small features

Stress: 4 story building



Too bouncy
Not dense enough

Post-Consumer Glass

OPTA GLASS RE-defined™
An OPTA Group Company

GGP
< 4 microns

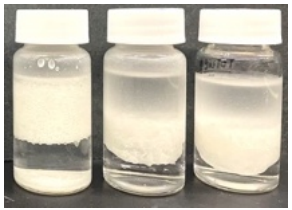
Density ~ 2.5 g/mL

EnRoute Interfaces, Inc.

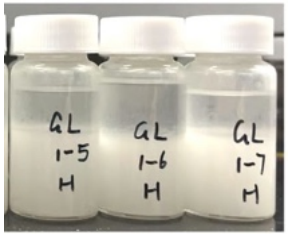
Hydrophobic

toluene

water



Hydrophilic



Amphiphilic

toluene

water

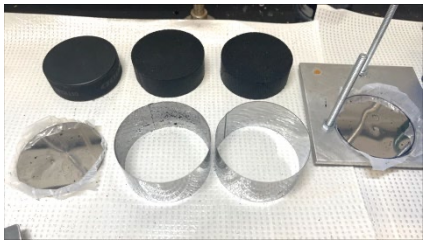
Combining Waste Targets Specifications

75%

5-10%

5-10%

Compression Molding



60 mph (95 km/hour)
Survives 5 impacts

Density 1.40
Better tensile strength
Still too bouncy

Silicones Filled with Reinforcing HPP Fillers

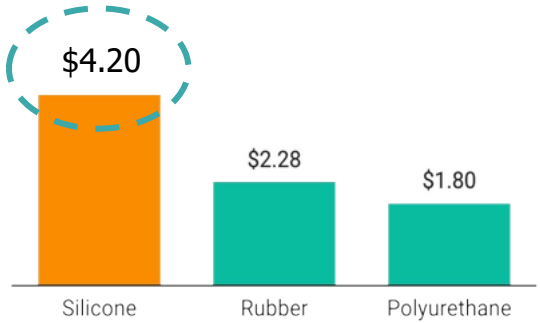
For Construction
In the field

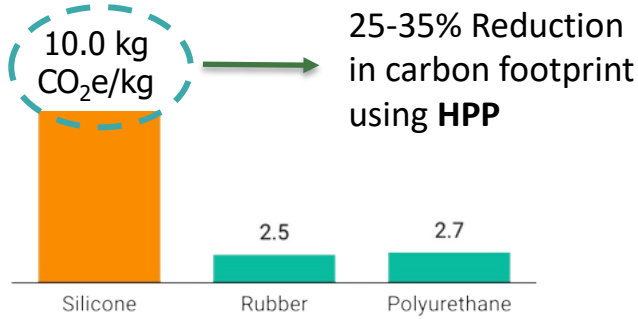
Adhesives

Sealants

Coatings 40% crumb

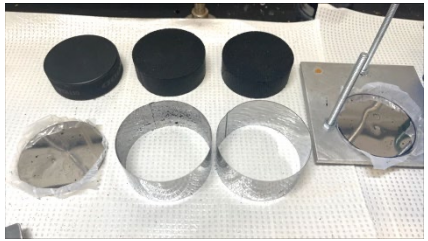
Cost and GHG Reductions with **HPP**





25-35% Reduction in carbon footprint using **HPP**

For Manufacturing
Compression molded objects



80% crumb

Waste Is a Valuable Feedstock for Silicones

Neopara MATERIALS

Waste is a resource, not garbage

Up-valuing waste reduces

COST CARBON FOOTPRINT

Silicone performance is maintained

REDUCING THE COST AND GHG IMPACT OF RTV SILICONES

BOOTH 736

END

Used Rubber Tires: High Value Low Value

New Tires

Used Tires

Combustion

Cement Kiln Fuel

Pyrolytic Recovery

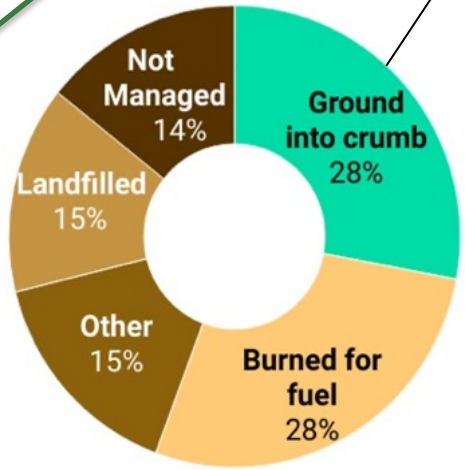
Volatile alkanes, Hydrocarbon oils, Carbon black

Oil

X

Devulcanization is difficult

Only 28% ground and used in new products



US Scrap Tire 2021

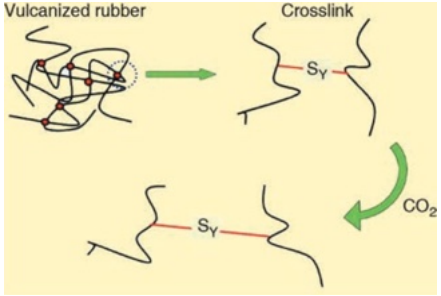
Used tires mostly end up in low value applications
The rubber retains excellent mechanical properties

Used Ground Tire Rubber: Excellent Performance, Low Value Applications

<US$1/kg

Padding/damping applications

De(Re)Vulcanization - **Tyromer**

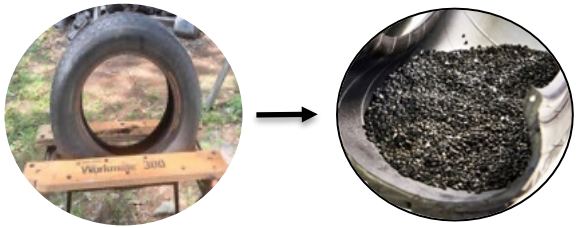


Athletic Fields

Filler in Asphalt

Use Waste as a Reinforcing Filler: Reduce Cost and GHG

We buy (widely available) ground up **used tire crumb**



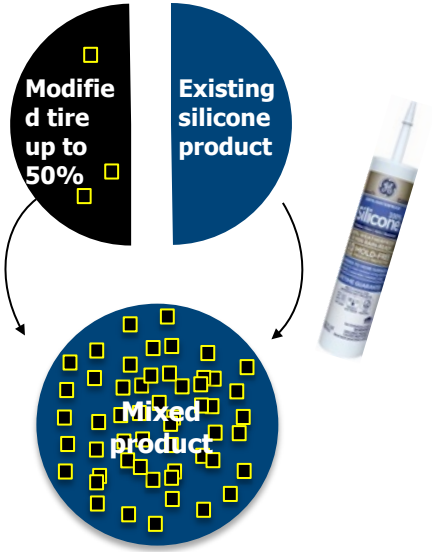
GTR

We process & modify it to **bond well with silicone**

HPP
High Performance Particles

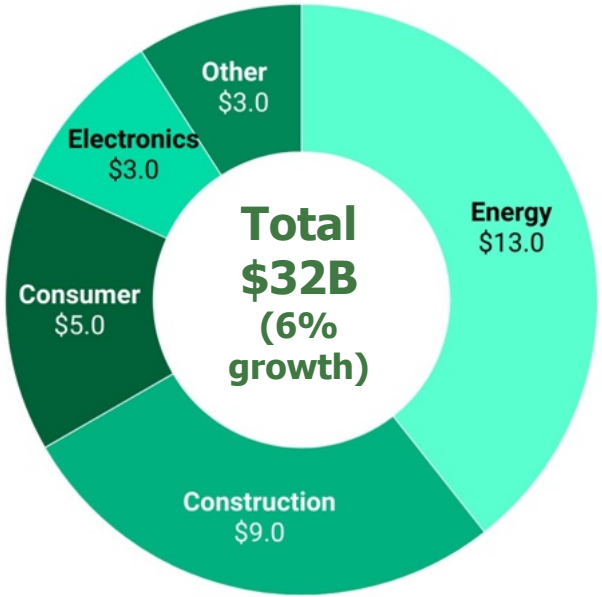
Patent Pending IP

We sell it as a **reinforcing filler** for silicone producers



Target: ~$9B construction silicone market

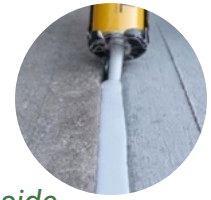
Global Silicone Market ($B)



Many volume and niche uses


Inside sealants

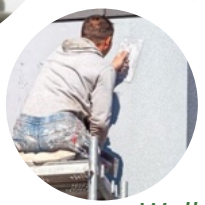

Roof coatings


Outside sealants


Masonry coatings

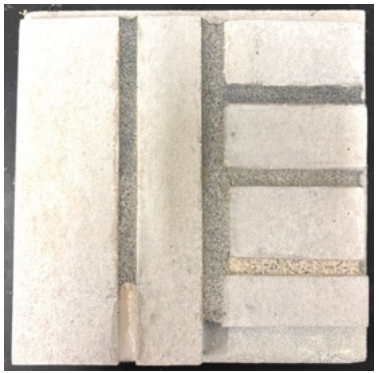

Window sealants


Expansion joints


Wall coatings

27

Physical Properties - Adhesives



C920 Required Tests	
C510 Test Method for Staining and Color Change	In Progress
C639 Test Method for Rheological (Flow) Properties	**PASS**
C661 Test Method for Indentation Hardness – Durometer	**PASS**
C679 Test Method for Tack-Free Time of Elastomeric Sealants	**PASS**
C717 Terminology of Building Seals and Sealants	N/A,
C719 Test Method for Adhesion and Cohesion	**PASS**
C793 Test Method for Effects of Laboratory Accelerated Weathering	In Progress
C794 Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants	**PASS**
C1183 Test Method for Extrusion Rate of Elastomeric Sealants	**PASS**
C1193 Guide for Use of Joint Sealants,	N/A
C1246 Test Method for Effects of Heat Aging on Weight Loss	**PASS**
C1247 Test Method Sealants Exposed to Continuous Immersion	In Progress
C1442 Tests on Sealants Using Artificial Weathering Apparatus	NO

28

Roofing silicone

30% **HPP** in white

with white pigment

green pigment

purple pigment

30% HPP (1-2 mm) yellow pigment

Concrete joint sealant

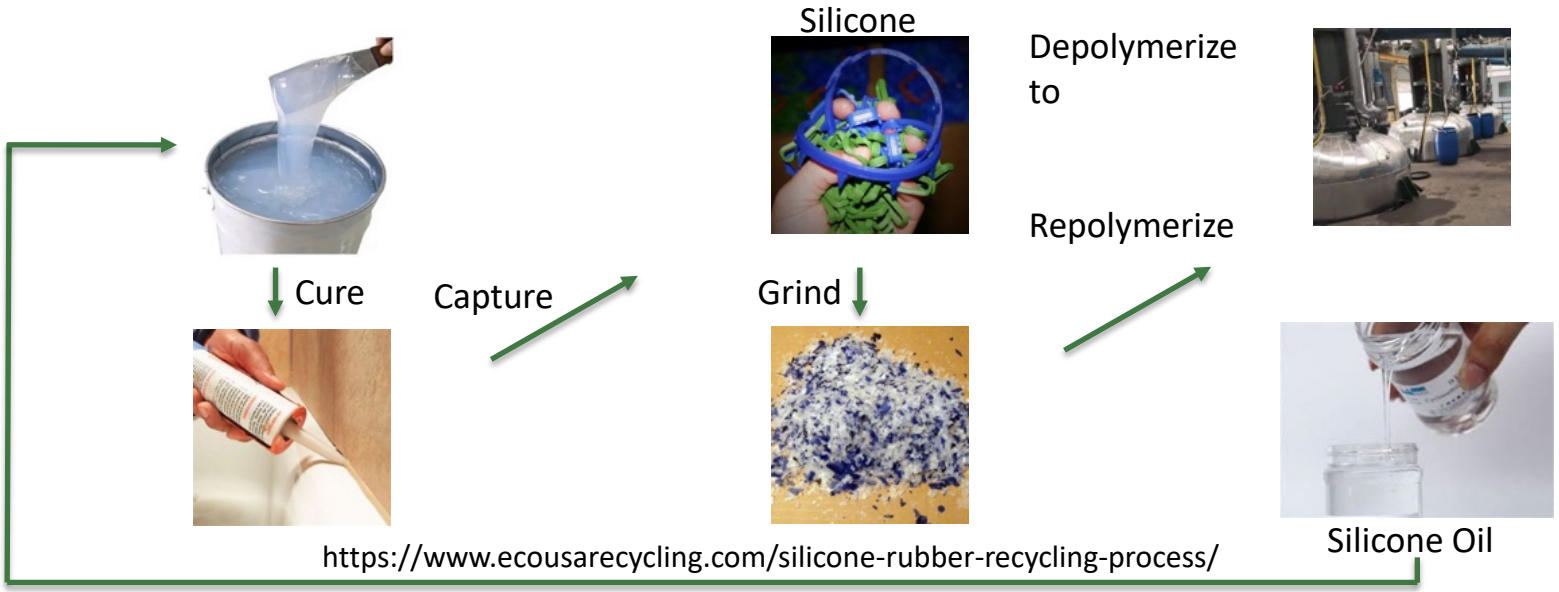
20% **HPP**

30% **HPP**

40% **HPP**

40% **HPP** (1-2 mm) in Concrete joint sealant

Silicone Rubber at End of Life: Recycle via Cyclic Monomers



[illegible].; Munsch, J.; Monteil, V.; Raynaud, J. et al., Gallium-catalyzed recycling of silicone waste with BCl_3. *Science* **2025**, *388* (6745), 392-400, DOI 10.1126/science.adv0919.

Wolf, A. T., Stammer, A., Chemical Recycling of Silicones. *Polymers* **2024**, *16*, 2220, DOI 10.3390-polym16152220.pdf

Recyclability and Circularity

Sustainability

Rubber-silicone composite elastomers can be recycled back to rubber crumbs and silicone oil **closing the life cycle loop**

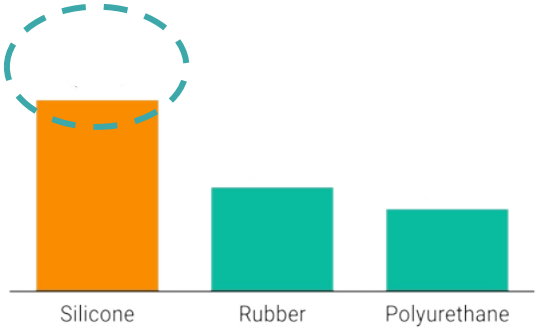
It is possible to repeatedly reduce carbon footprint after each rotations of the cycle

Silicone Elastomers: High Value Materials, BUT

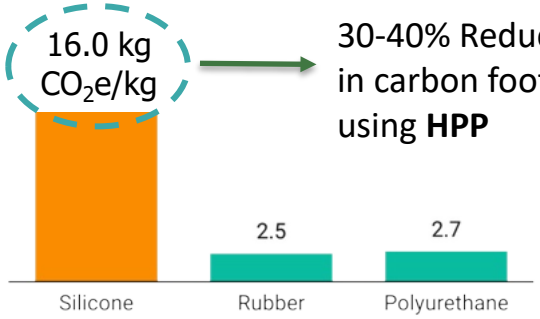
Adhesives

Coatings

Sealants



Cost and GHG-footprint are barriers to adoption

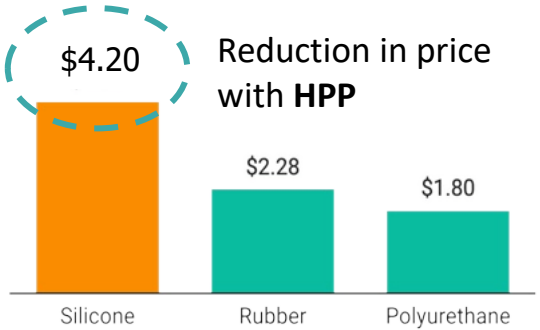


32

Opportunities – Equivalent Performance + Benefits

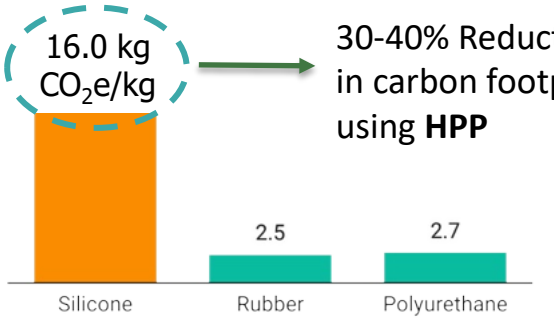
Formulate from scratch (rather than add-ons)

- Optimize mechanical/physical properties
- Displace more expensive fillers
- Displace high carbon footprint fillers – fumed silica



Reduction in price with **HPP**

Cost and GHG-footprint are barriers to adoption



30-40% Reduction in carbon footprint using **HPP**

34

End of Life vs Recycling

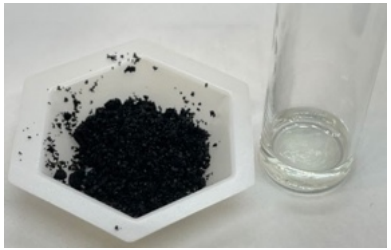
Low Volume Applications – will end up in the environment

Bead of Silicone →

High Volume Applications - easy to recover, and recycle, but are they recovered?

HPP in silicones are easily recycled

Rubber-silicone composite elastomer

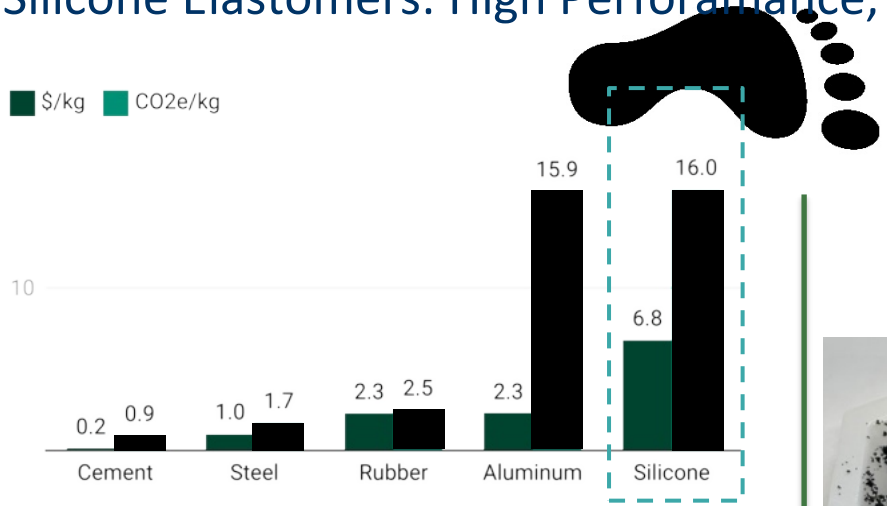


Silicone oil

Each loop shrinks the footprint

Separation

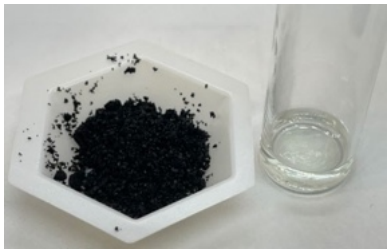
Silicone Elastomers: High Perforamance, but



Dilute with Post Consumer waste (up to 50%)

- Lower cost
- Lower GHG

Rubber-silicone composite elastomer



Silicone oil

Separation

Conclusions

Sustainability and Silicone Elastomers

Reuse –
Thermoplastic elastomers;
Dynamic bonds

Repurpose - Redox sensitive crosslinks

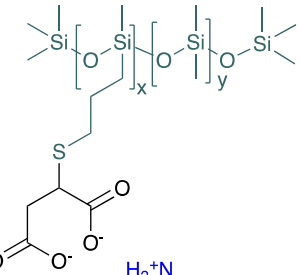
Recycle - Devulcanization
to polymer oils, recycled fillers

Degradation in the Environment
Compostable silicone elastomers
degradable crosslinks
oils spontaneously degrade

Dilute and Recycle

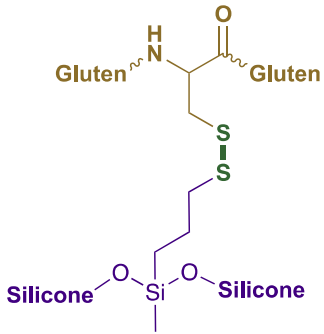
Rubber reinforced silicone

Neopara MATERIALS

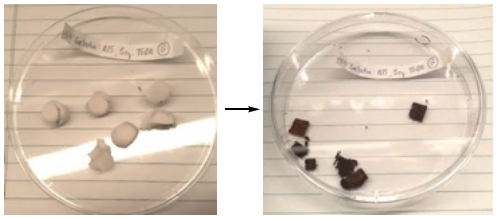


Thermoplastic - Ions

Redox - disulfides



Compostable – protein silicones



Different Size Particles – Different Grip (30 wt% Loading)

Small particles
(<250 micron)

Small particles
(<250 micron)

Passes tests for

- Strength
- Hardness
- Stretchiness (extension)
- Waterproof
- Flammability

Small particles
(<250 micron)

Big particles
(~2500 micron)

Silicones and Circularity

Environmental Degradation ***Oils degrade quickly***

Recycle

ReUse
RePurpose