

New Sustainable, High Performance Oligomers
for Inks, Coatings and 3D Printing

RAHN

Why go sustainable?

Increasing public awareness and further government directives

European Directives

Recent EU directives:

- Cut carbon emissions by 55% by 2030
- Net zero greenhouse gas emissions (GHG) in the EU by 2050 – June 2021
- Single-Use Plastics Directive - 3 July 2021



Sustainable Materials

Sustainable materials can have a superior environmental profile. They can:

- Reduce the carbon footprint
- Be renewable
- Be part of a circular based solution
- Reduced crude oil dependency

Sustainable Bio-based Products

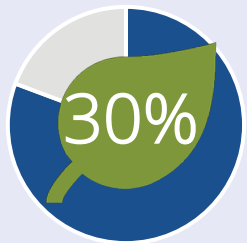
Increasing public awareness and further government directives

Bio-based

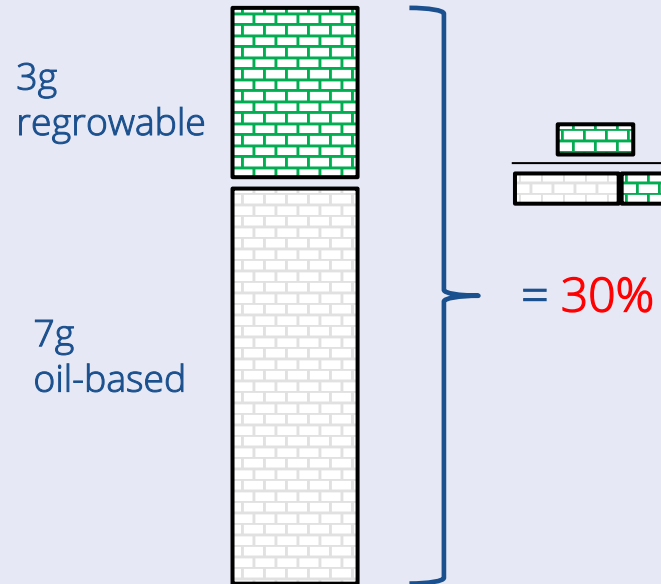
- According to The Food and Agriculture Organization (FAO) Biomass is any material of biological origin, for example wood, dung or charcoal and it excludes material embedded in geological formations and transformed to fossils.
- A bio-product is a product containing all or some biomass
- The links between bio products and food security are complex and sometimes "bio" is not enough. Some producers stipulate biomass needs to come from non-food sources.



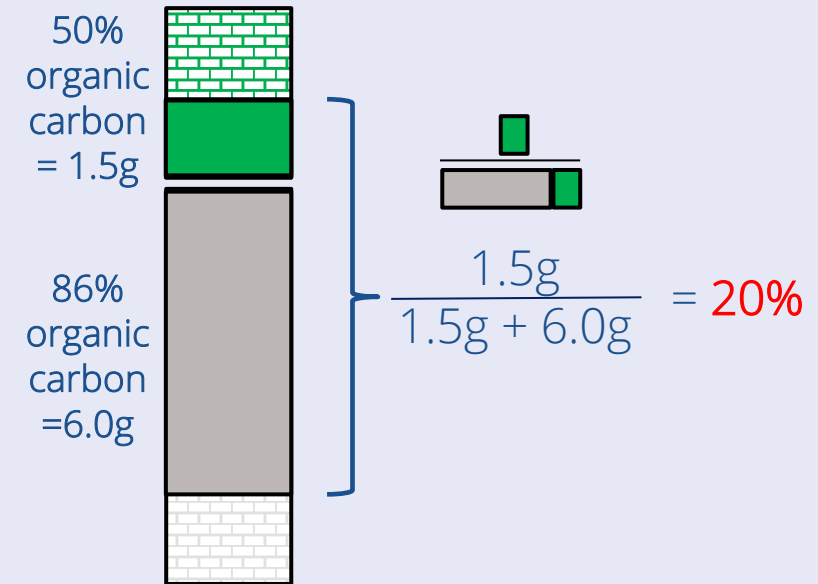
Calculating Bio Content



Bio-renewable
content



EN 16785-1
Bio-based content



ASTM D6866 – EN16640
Bio-based **carbon** content

The Latest Bio-based Products from RAHN

Bio-based Products

Bio-based UV curable oligomers have been around for a long time but these were not designed with sustainability in mind. They tend to be either:

- Slow curing e.g. epoxydised soya bean oil acrylates
- Low bio based content e.g. fatty acid modified epoxy acrylates (14%)
- In 2019 RAHN looked to create high bio content, high performing bio-based products that could compete directly with oil-based products
 - 2 new products released
 - More to come





GENOMER* 3143

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GENOMER* 3143

Product Overview

PRODUCT OVERVIEW

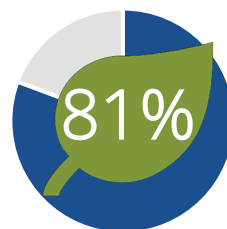
GENOMER* 3143 Bio-based aliphatic polyester acrylate. Resin for radically curable inks and coatings, adhesives and 3D-printing.

- Hard and scratch resistant when cool
- Tacky at elevated temperature
- Heat and pressure can laminate substrates

Functionality	1
Colour index	< 100 APHA
Viscosity, 50°C	1'500 - 3'500 mPas
Glass transition, T _g	28°C
Acid number	≤ 10 mg KOH/g

VALUE ADD

- ✓ **Unique** in its **chemistry** and **structure** which allows the special **thermoplastic**-like behavior you were always looking for
- ✓ Its **very high share of plant-based content** improves your CO₂-footprint while providing the same technical performance as an oil-based product
- ✓ Sustainable GENOMER* 3143 with **high performance**



Bio-renewable
content

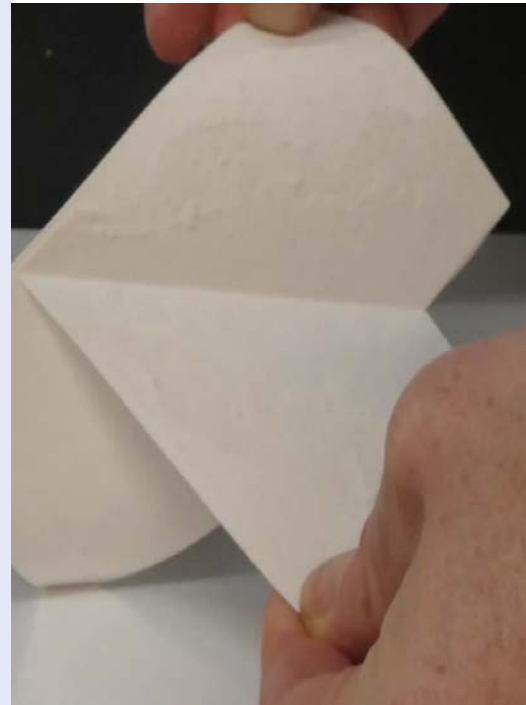
Thermoplastic and heat sealing

THERMOPLASTIC-LIKE BEHAVIOR



GENOMER* 3143 exhibits significant hardness at room temperature but softens – and even melts – at elevated temperatures.

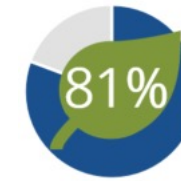
HEAT SEALING








Adhesives can be formulated to be

- Tack free at ambient temperature
- Tacky at elevated temperature
- Heat and pressure then laminates substrate

Summary of GENOMER* 3143



Bio-renewable content

Description	Bio-based aliphatic polyester acrylate
Properties	<ul style="list-style-type: none"> ✓ High transparency and clarity ✓ Low yellowing ✓ Thermoplastic-like behavior ✓ Partly water solubility after curing
Application	<ul style="list-style-type: none">  Inks and coatings  Adhesives  Heat sealable coatings  Deep drawing  3D-printing





GENOMER* 4293

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GENOMER* 4293

Product Overview

PRODUCT OVERVIEW

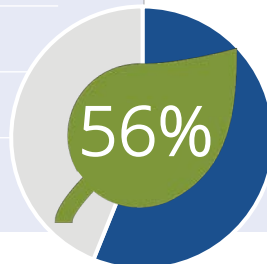
GENOMER* 4293 Bio-based aliphatic polyester urethane acrylate. Resin for radically curable inks and coatings, adhesives and 3D printing.

- High viscosity but it can be rapidly reduced by adding reactive diluent

Functionality	2
Colour index	< 100 APHA
Viscosity, 60°C	15'000 - 35'000 mPa*s
Glass transition, T _g	67°C

VALUE ADD

- ✓ **Unique** in its **chemistry** and **structure** which allows a special **thermoplastic affect**
- ✓ Improves your CO₂-footprint with a **high share of plant-based content** while providing the same technical performance as an oil-based product
- ✓ Exhibits **outstanding hardness and scratch resistance** in inks and coatings
- ✓ 3D-Printing with **shape memory effect** after curing

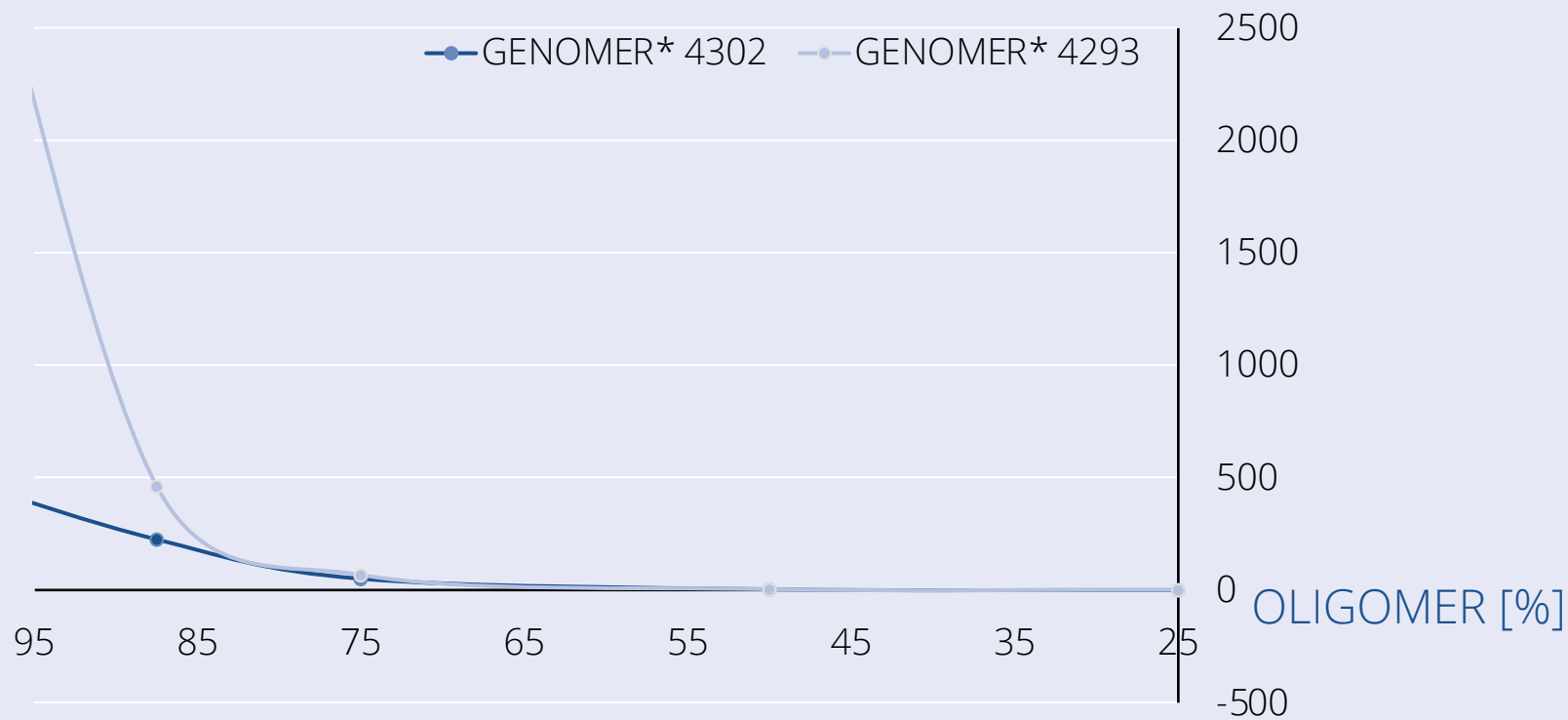


Bio-renewable
content

GENOMER* 4293 Viscosity Dilution Curve

Good solubility in reactive diluents – dilution with TMP(EO)TA

VISCOSITY [Pa*s]



GENOMER* 4293
exhibits high
viscosity which can
be rapidly reduced
by adding
monomer

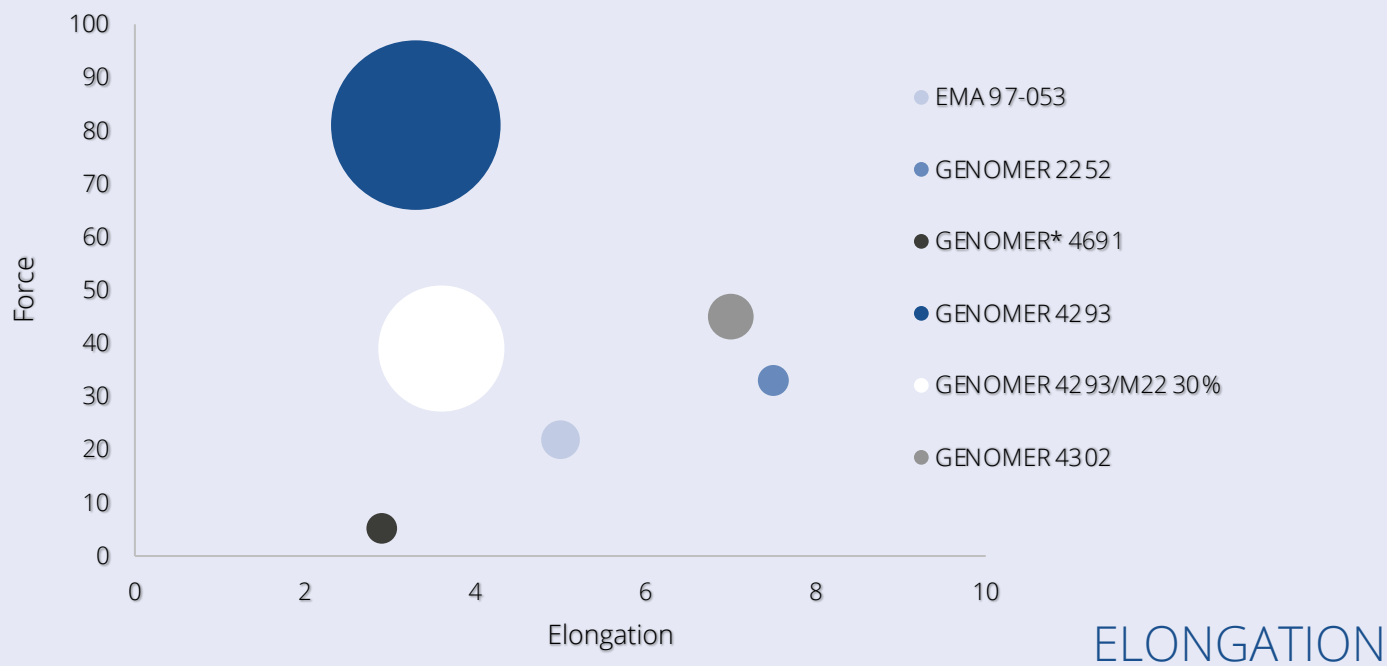
At:

25% TMP(EO)TA = 66 500 mPa.s

50% TMP(EO)TA = 2 920 mPa.s

GENOMER* 4293 Mechanical Properties

FORCE



MECHANICAL DATA

E-Modulus	3180 MPa
Tensile strength	81 MPa
Elongation	3.3%
Shore hardness	D86

Bubble size is hardness:

- GENOMER*4293 is compared against other typically hard GENOMER grades
- GENOMER*4293 exhibits very high hardness and allows dilution with flexible reactive diluent to improve toughness (see GENOMER 4293/M22 30%)

Summary of GENOMER* 4293

Bio-renewable
content








Description

Bio-based aliphatic
polyester urethane acrylate

Properties

- ✓ Exceptional hardness
- ✓ High scratch and abrasion resistance
- ✓ High transparency + clarity
- ✓ Low yellowing
- ✓ Thermoplastic-like behavior
- ✓ Good stain resistance
- ✓ Good solubility in reactive diluents

Application

-  3D formulations
-  Scratch resistant inks and coatings
-  Laminating adhesives
-  Heat seal coatings
-  In-mold decorative inks



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3D and Sustainability

Bio-based Products

3D printing is already considered more sustainable:

- Additive manufacture => less waste.
- Make what is required => energy efficient / less waste
- Improved design => less waste

Sustainability can be further improved by using sustainable raw materials.

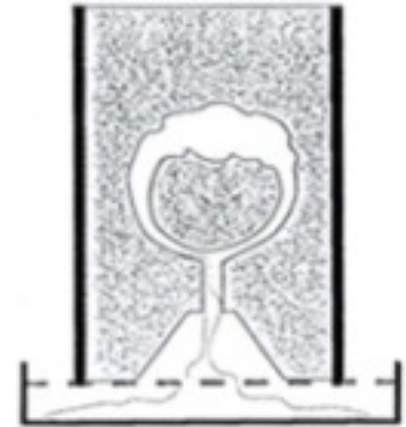


GENOMER* 3143 - Lost Wax Casting

- Used for jewellery and model making
- Wax like substance is 3D printed using UV or daylight curing
- The mould is then surrounded by gypsum plaster
- Burnt out at high temperature $>700^{\circ}\text{C}$



- Low thermal expansion coefficient
- Optimized burnout performance
- Usually higher burn out temperature due to cross-linking



Thermoplastic and memory effect

3D Printed using GENOMER*4293

HEAT AND PRESSURE



COOLED



HEAT



Exchanging STD U(M)A with GENOMER*4293

	Tough 1W5	Full	50%
E modulus, MPa	1726	2820	2650
Tensile at Yield, MPa	34	35	59
Elongation (%)	29	1.6	19

GENORAD*4293

- Increases stiffness
- Improves strength
- Improves toughness
- Reduces elongation
 - Re-balancing the formulation could achieve even better results



Current situation

Bio-based Products

- More raw materials becoming commercially available to allow various polyester acrylates or urethane (meth)acrylates to be synthesised.
- These bio-based oligomers can out-perform some traditional bio-based chemistries
- Bio-based oligomers have the potential to be used in several end-use applications
- New products are restricted by:
 - Low level of raw materials at the commercialisation stage
 - Few high curing biobased monomers available
 - REACH and TSCA registration impeding new products



Conclusions

- New bio-based oligomers can out perform some traditional bio-based chemistries
- Bio-based oligomers have the potential to be used in several end-use applications
 - Wood coatings
 - Top coats
 - Inks
 - Adhesives
- Several bio-based oligomers show excellent performance in 3D applications
 - 3D printing has the potential to be even more sustainable
- GENOMER* 3143 and GENOMER*4293 already released and available
 - More products in the pipeline!



RAHN Bio-based Product Flash



Product Flash

Bio-Based Contents of RAHN-Products

No. 1 April 2020

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THANK YOU
FOR YOUR ATTENTION