Gloxil iM16k A

in Polyamide and Polypropylene –

The easy way towards future.

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We supply material for good ideas

Contents

Status Quo

- In recent years, the topic of lightweight construction has steadily increased in importance, especially in the area of traffic and transport.
- Thermoplastics play an important role here, including polyamide and polypropylene. These already have relatively low densities and thus component weights.
- Various options are available for further weight optimization, and hollow glass microspheres play a particularly important role here.
- 3M™ Glass Bubbles are used for this purpose due to their positive properties.
- Surface functionalization by means of covalent bonding of organofunctional silane is a suitable method for optimizing mechanical properties.

Objective

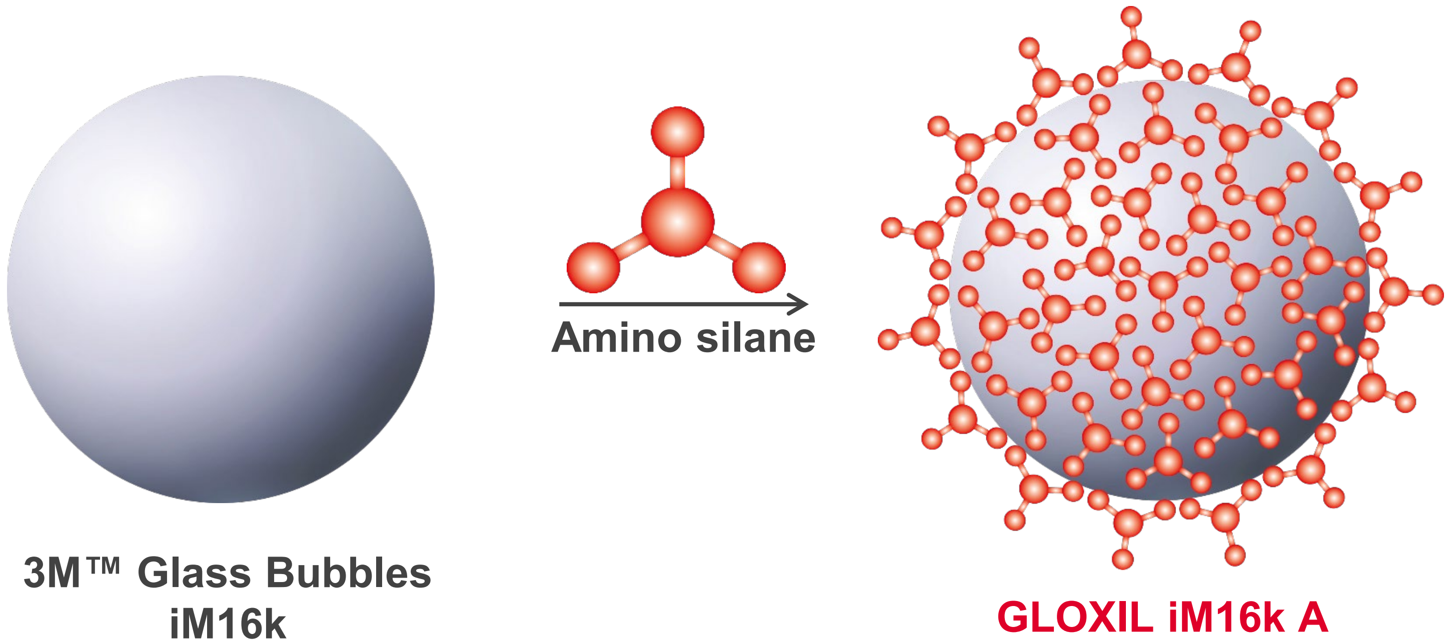
To show positive effects of surface functionalization in

- Polyamide PA6 and
- Polypropylene Copolymer

of GLOXIL iM16k A compared to 3M™ Glass Bubbles iM16k on the mechanical property profile

Surface Functionalization

A special process creates the GLOXIL iM16k A based on the micro hollow glass sphere 3M™ Glass Bubble iM16k



Characteristics GLOXIL iM16k A

Density	[g/cm³]	0.46
Particle size D_{50}	[µm]	22
Particle size D_{97}	[µm]	45
Specific surface area BET	[m²/g]	2
Air jet screening > 125 µm	[%]	0.2
Flotation rate	[%]	96
pH		10
Color L* (CIELAB)		98
Functionalization		Amino

Typical properties, no specification

Polyamide PA6 Ultramid® B3K	PP Copolymer Bormod™ BF970MO
Hollow glass bubbles only	Hollow glass bubbles only
Combination: Glass fibers + hollow glass bubbles	Combination: Talc / hollow glass bubbles

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Objective:
Density / weight reduction and still good mechanical properties

PA Compound Ultramid® B3K BASF Melt volume rate MVR 160 cm³/10 min (275 °C, 5 kg)		
3M™ Glass Bubbles iM16k	0 to 14 % (m/m) 0 to 29 % (v/v)	---
GLOXIL iM16k A	---	0 to 14 % (m/m) 0 to 29 % (v/v)
Total	**100**	**100**

All results were determined in the freshly molded (dry) state

Data determined by 3M Advanced Materials Division, Special Additives Laboratory

Density and Weight Reduction

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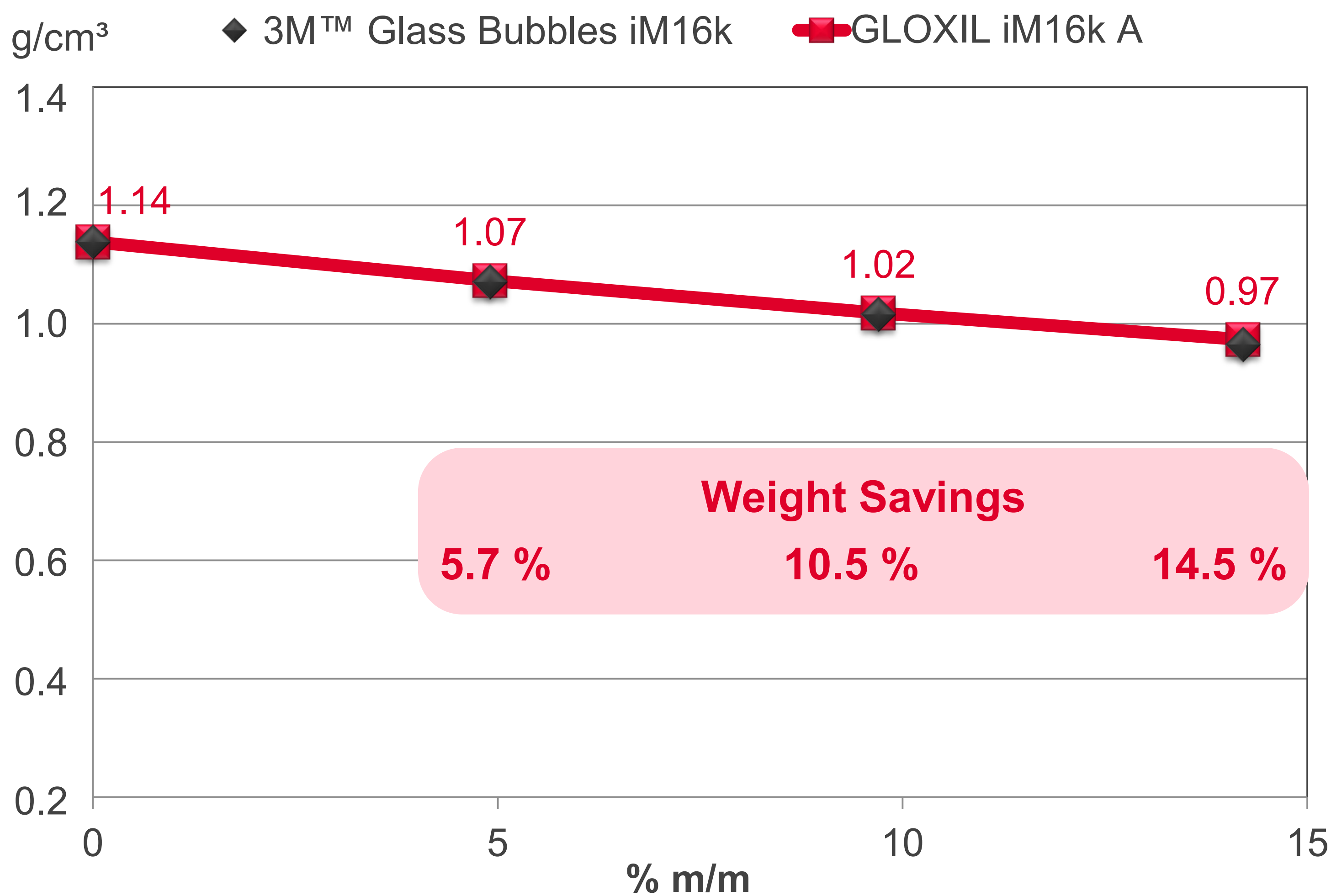
measured



Tensile Modulus

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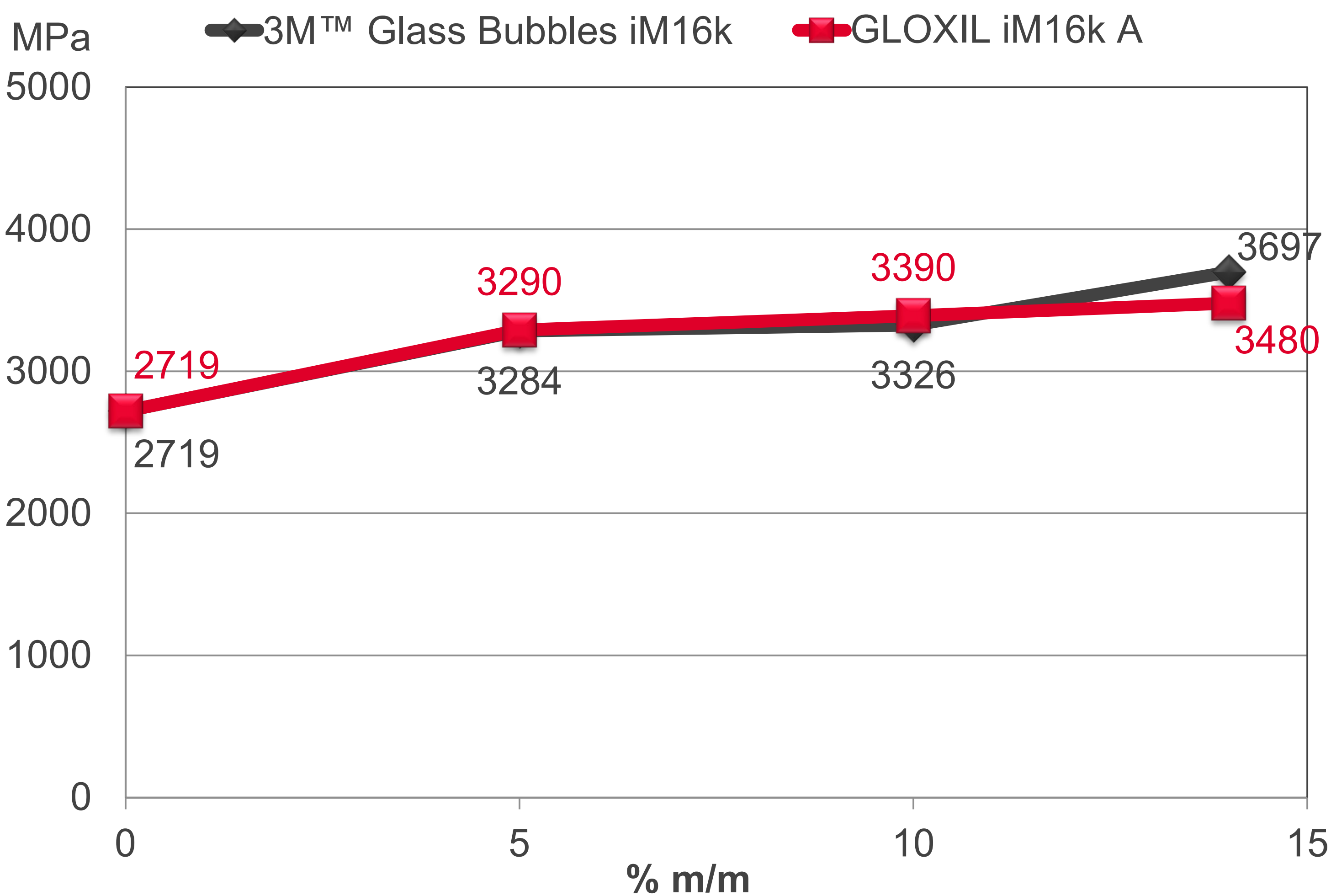

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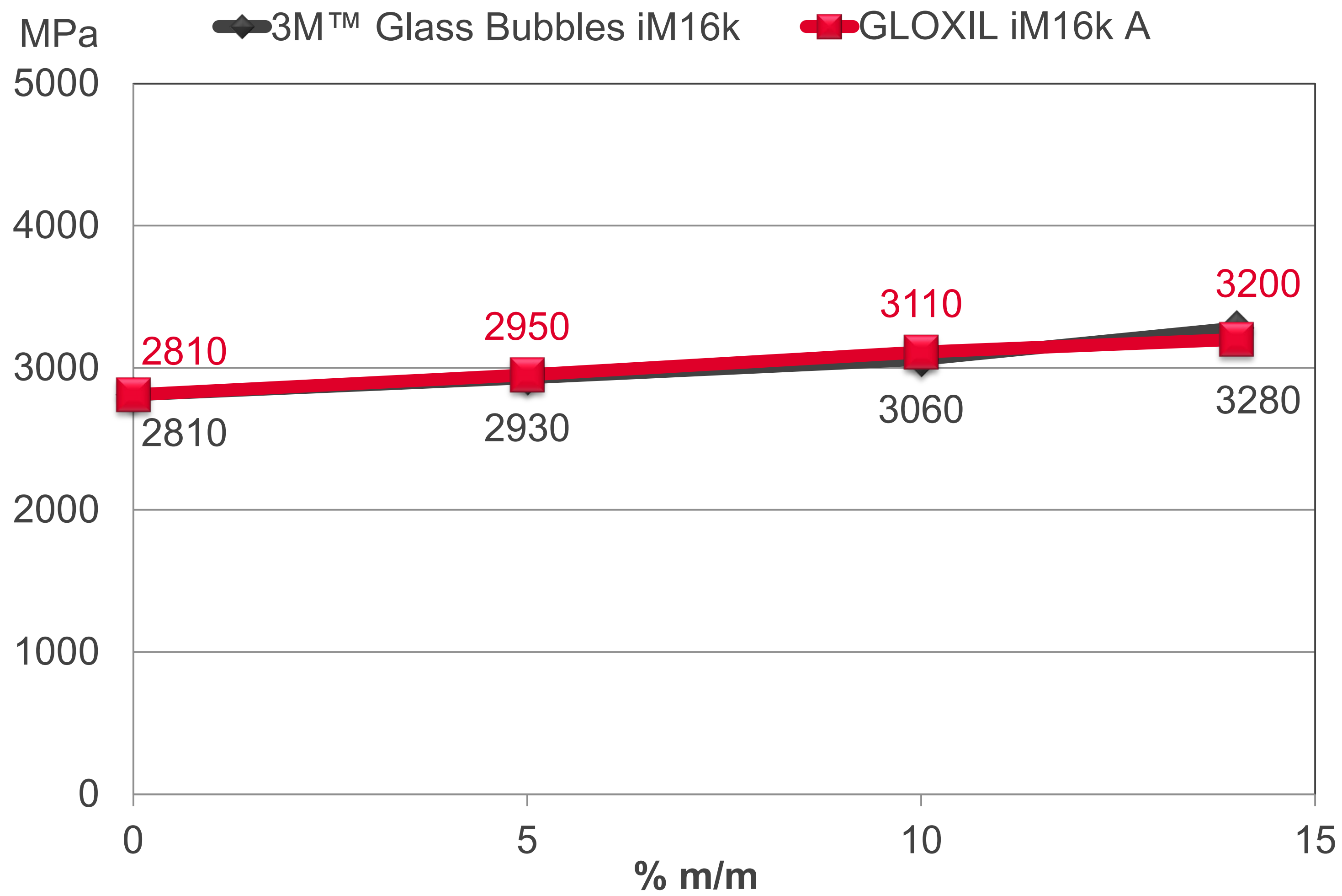

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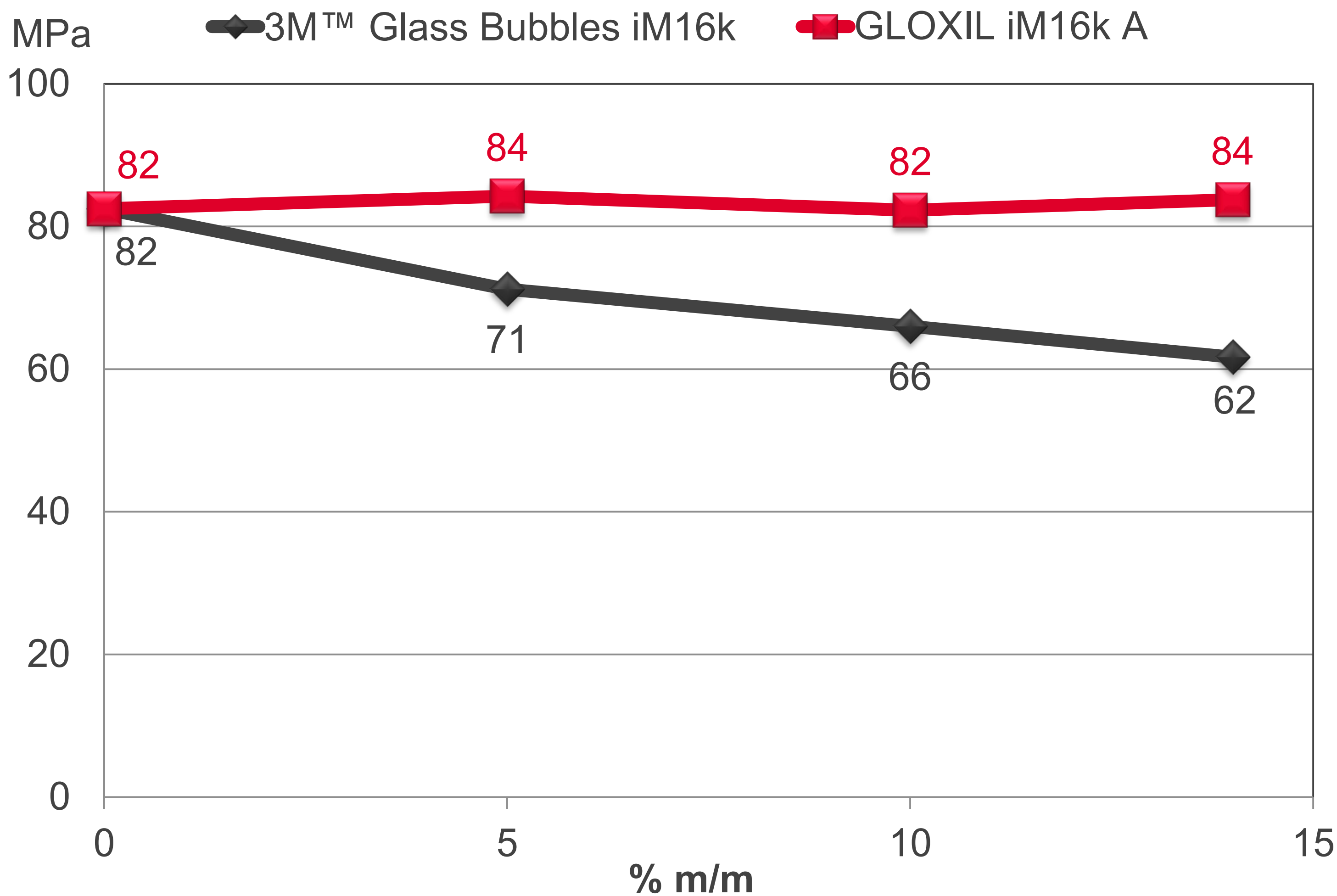

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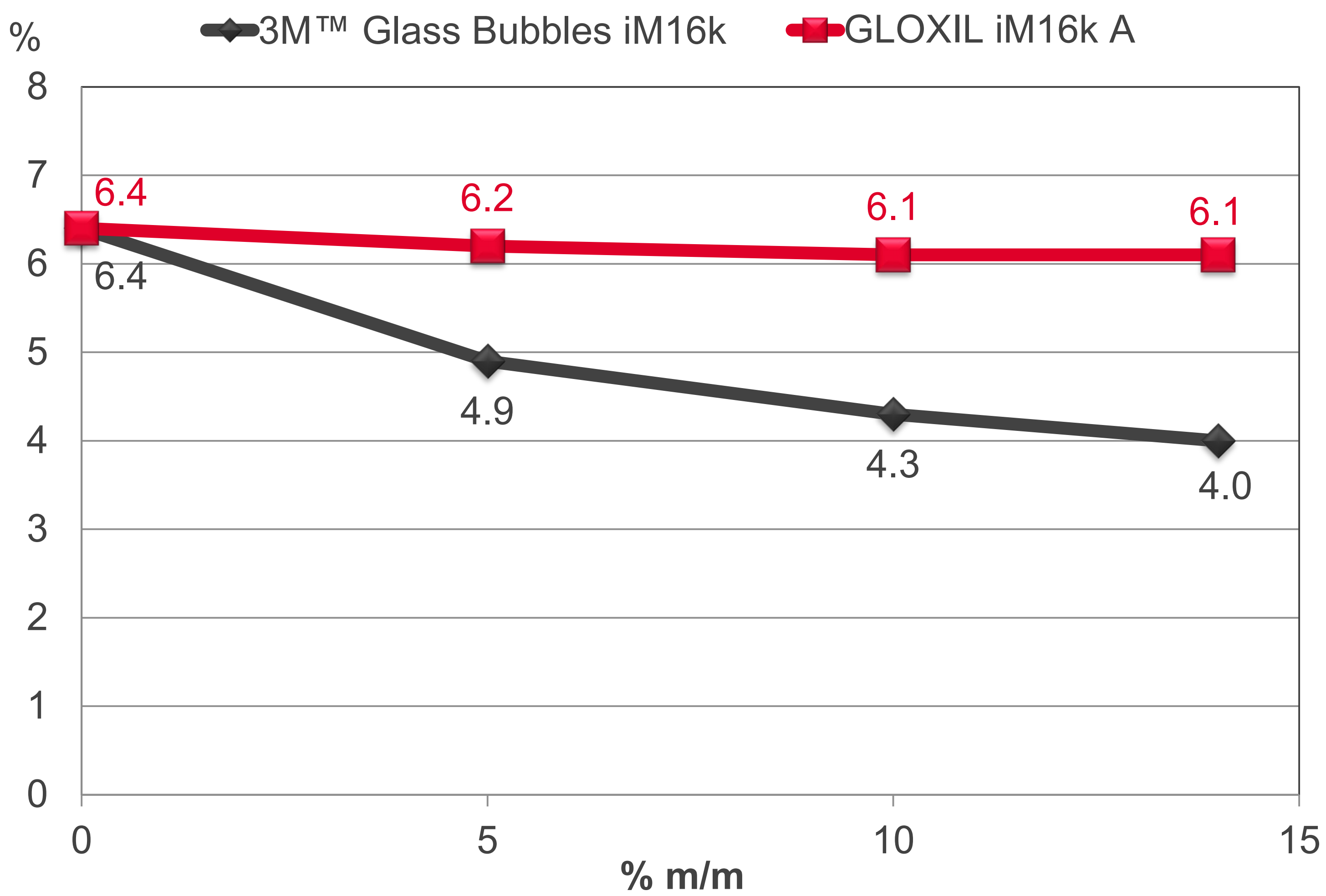

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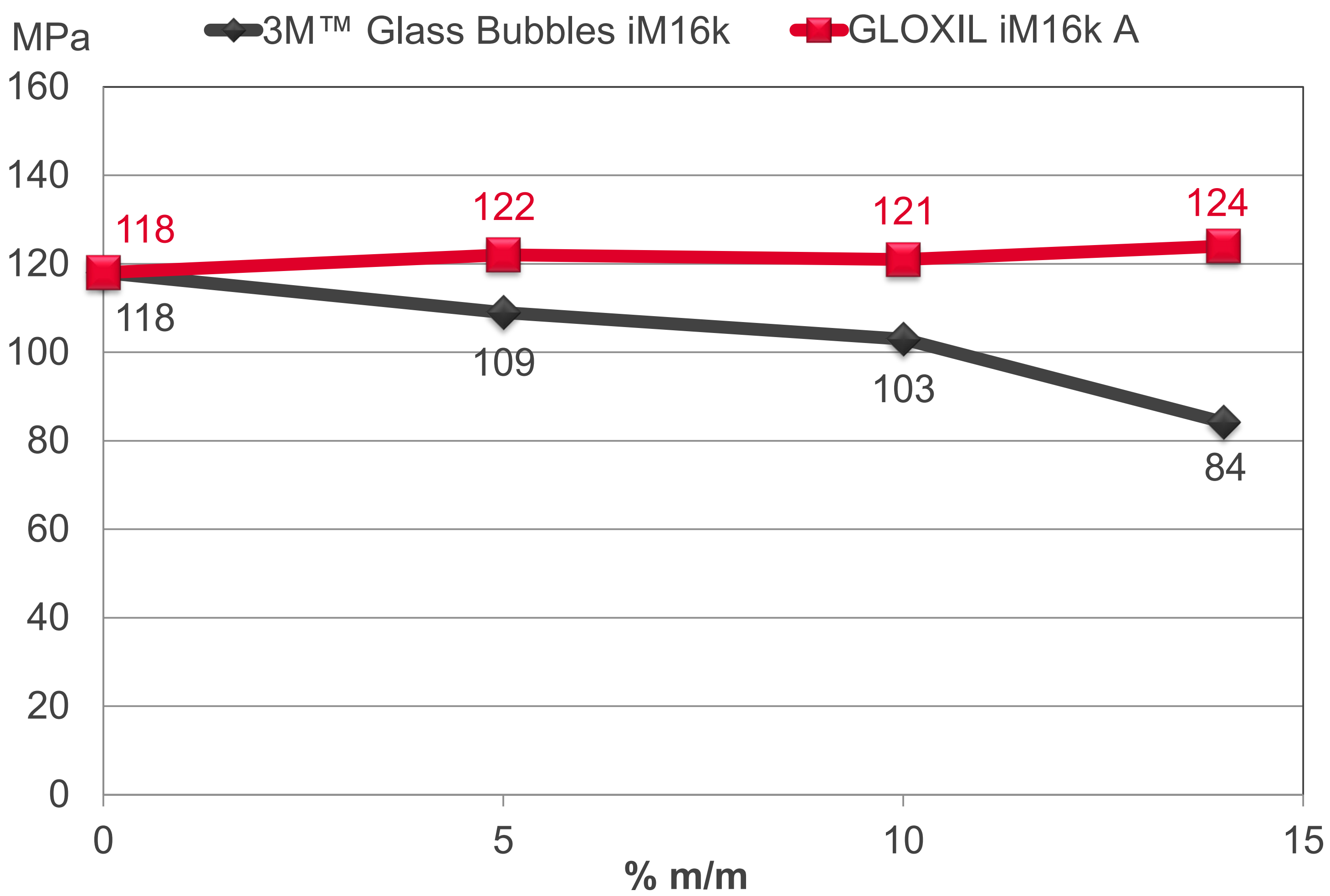

Flexural strain

at flexural strength

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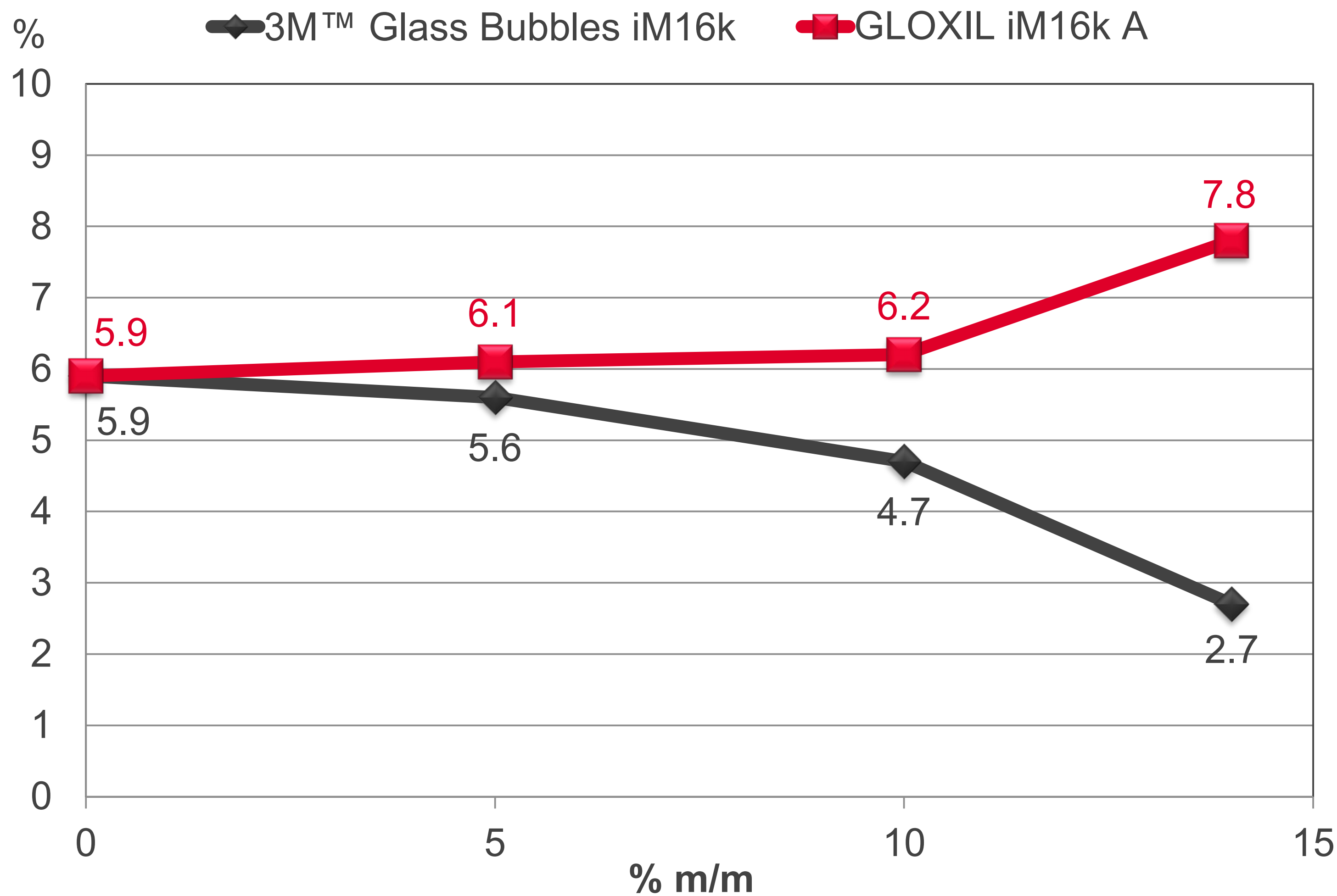

Impact Strength Charpy

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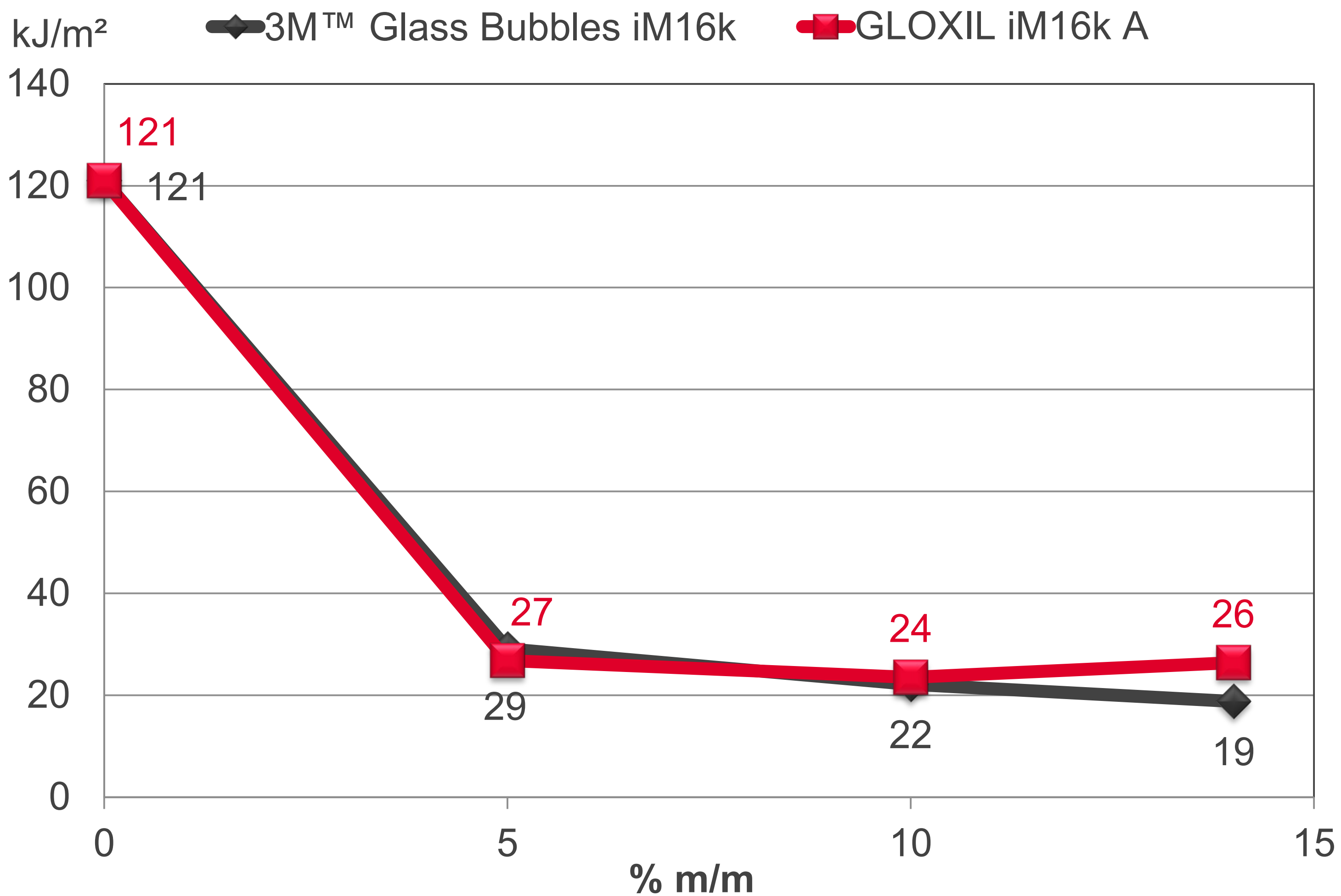

Notched Impact Strength Charpy

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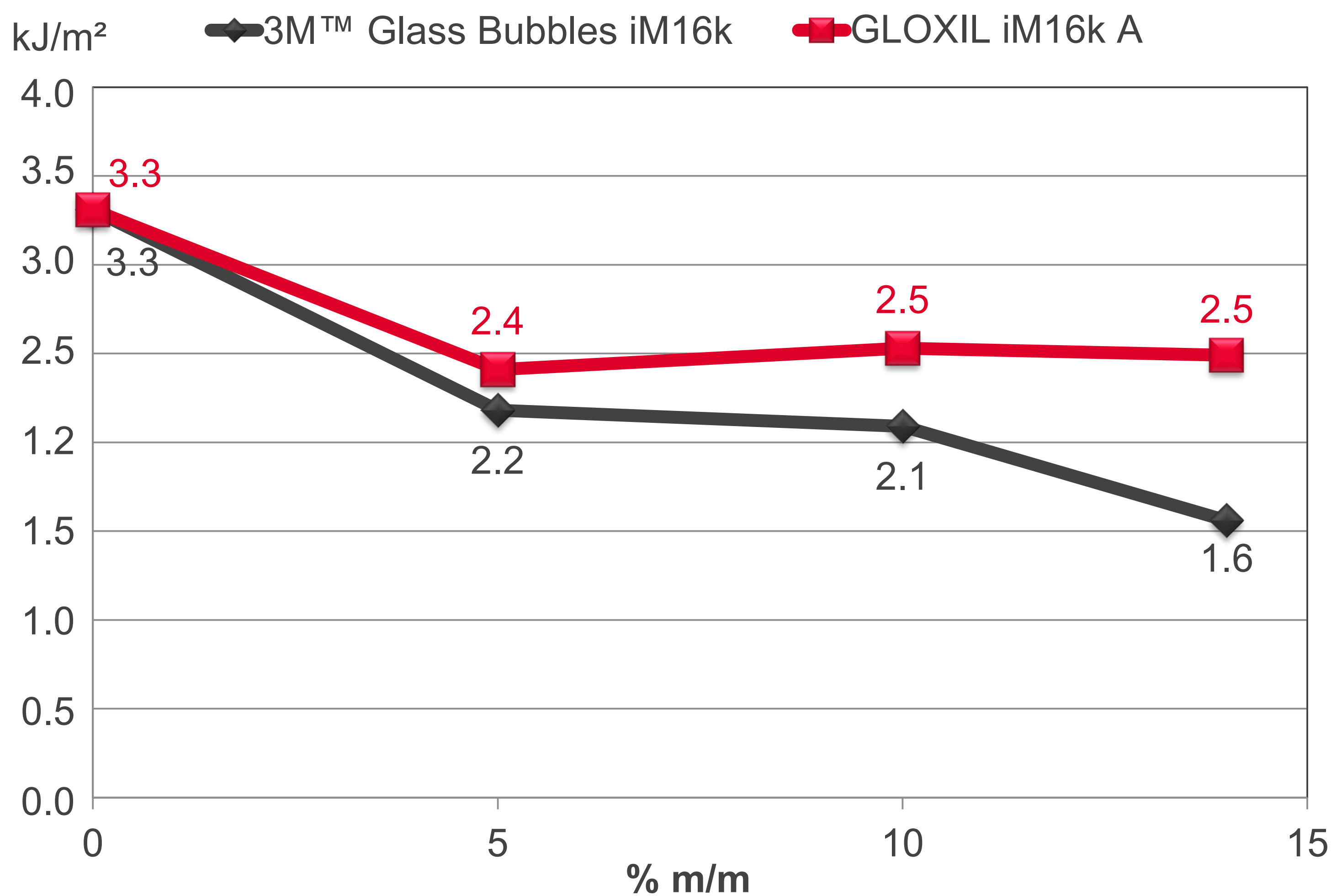

Summary

PA6

GLOXIL iM16k A shows in comparison to the untreated hollow glass spheres:

- Same density and thus weight saving potential
- Comparable increase in stiffness (tensile modulus and flexural modulus)

+ Significantly higher yield stress, largely independent of the filler content at the level of the unfilled PA6
+ Significantly higher yield strain, largely independent of the filler content at the level of unfilled PA6
+ Significantly higher flexural strength, with increasing filler content even higher than the unfilled PA6
+ Slightly higher impact strength
+ Slightly higher notched impact strength

→ Objective achieved:
density / weight reduction and good mechanical properties

+ Expectation: improved scratch resistance

More Results PA6
Glass Fibers + Glass Bubbles

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Objective:
Increase of filler content/stiffness without increase of density/weight and still good mechanical properties

PA Compound Ultramid® B3K BASF Melt volume rate MVR 160 cm³/10 min (275 °C, 5 kg)			
Glass fibers	15 % (m/m) 8 % (v/v)	17 % (m/m) 8 % (v/v)	17 % (m/m) 8 % (v/v)
3M™ Glass Bubbles iM16k	---	4 % (m/m) 10 % (v/v)	---
GLOXIL iM16k A	---	---	4 % (m/m) 10 % (v/v)
Total	**100**	**100**	**100**

Data determined by 3M Advanced Materials Division, Special Additives Laboratory

Density

measured

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+ Glass Bubbles

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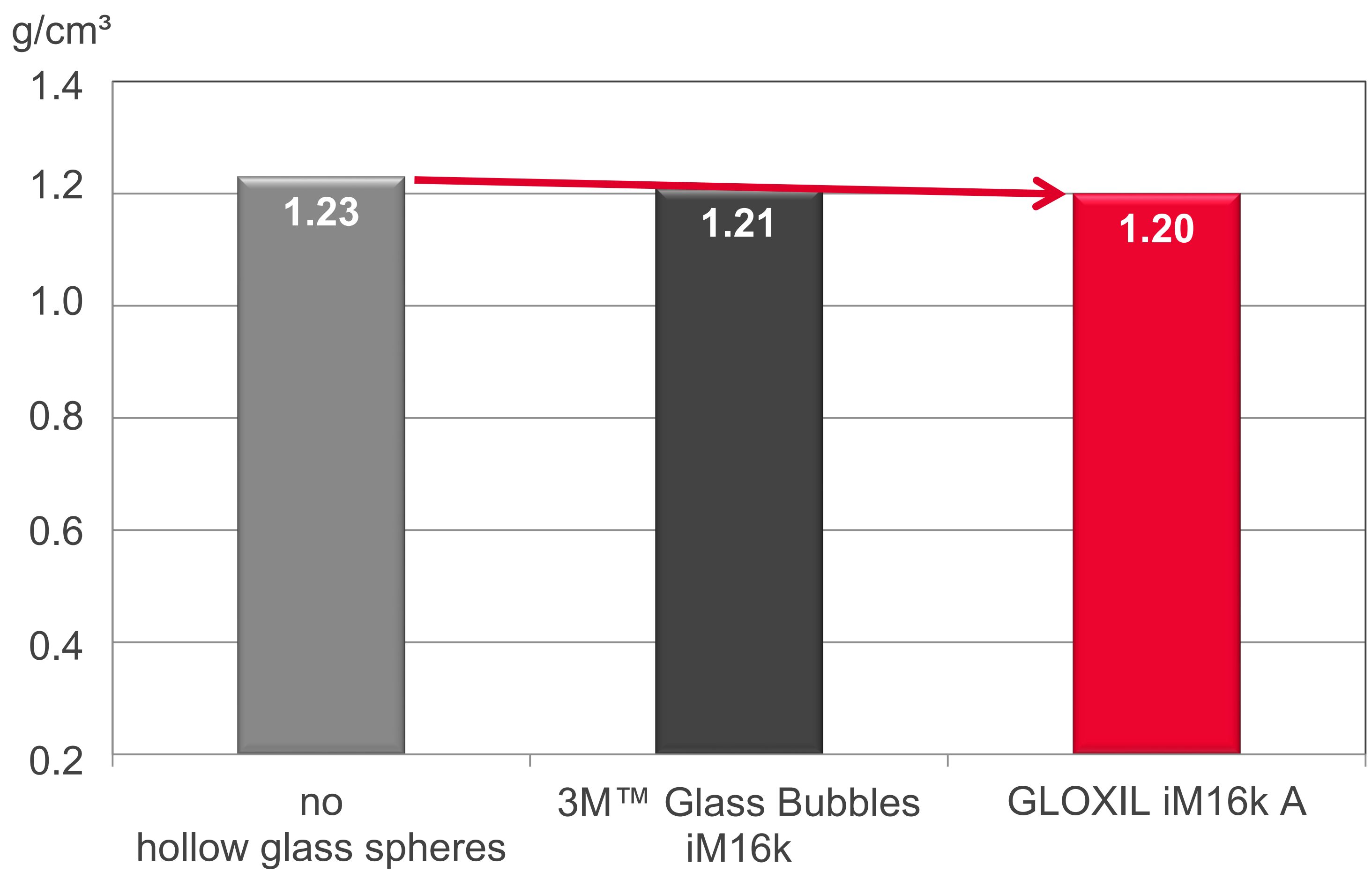
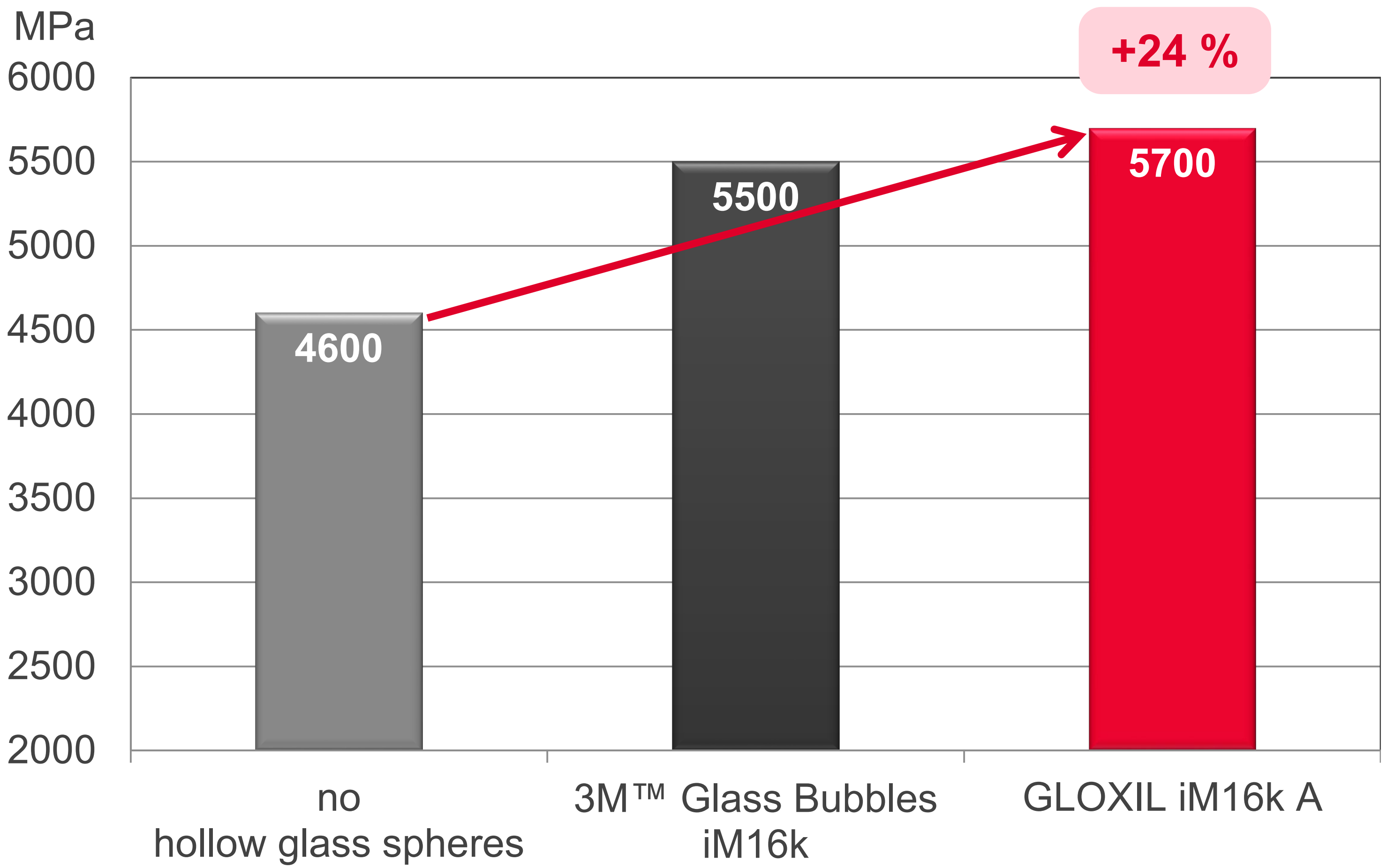


4 % m/m = 10 % v/v

Tensile Modulus



4 % m/m = 10 % v/v

Flexural Modulus

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+ Glass Bubbles

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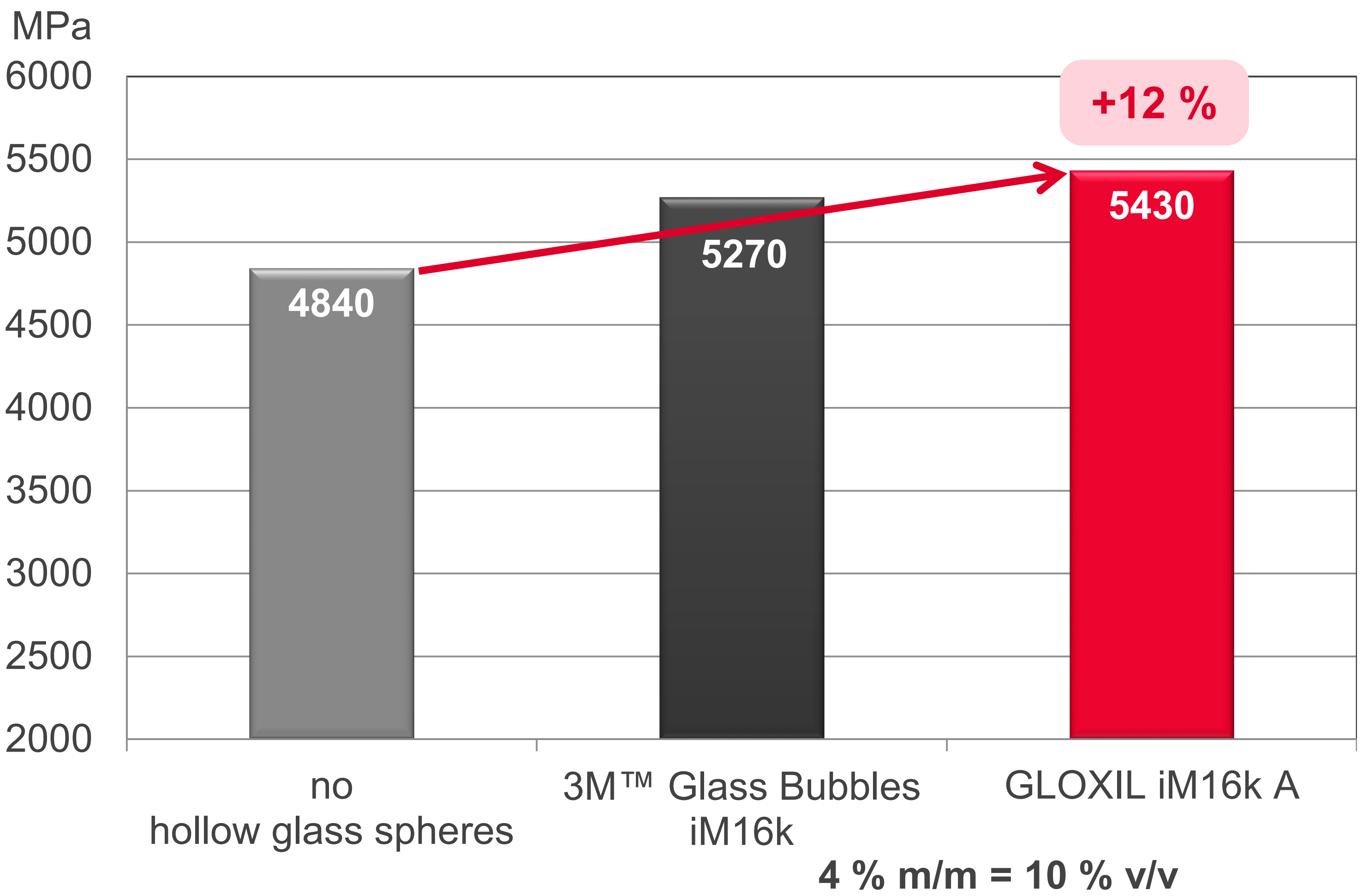
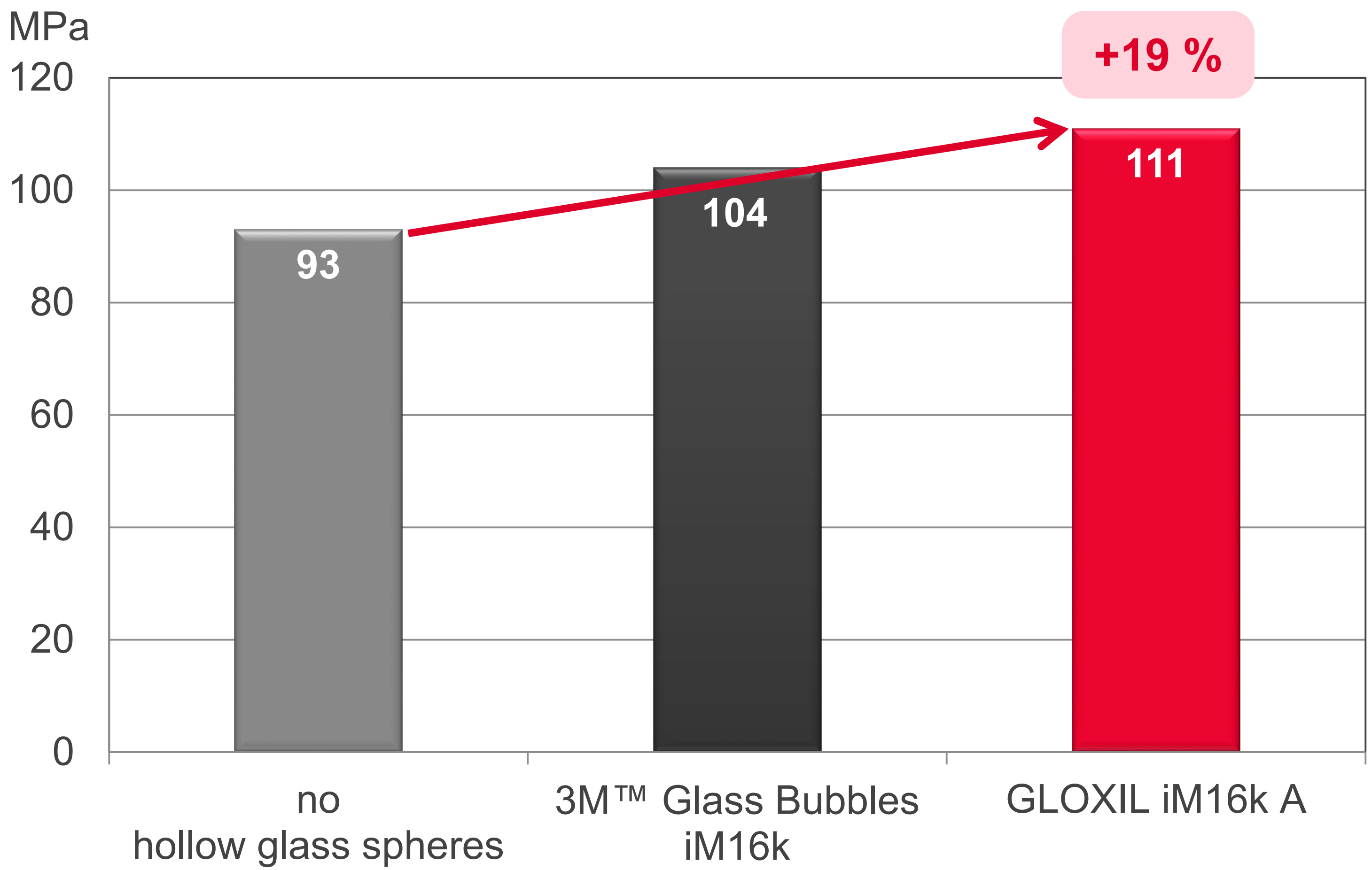


Tensile Strength



4 % m/m = 10 % v/v

Tensile Strain at Break

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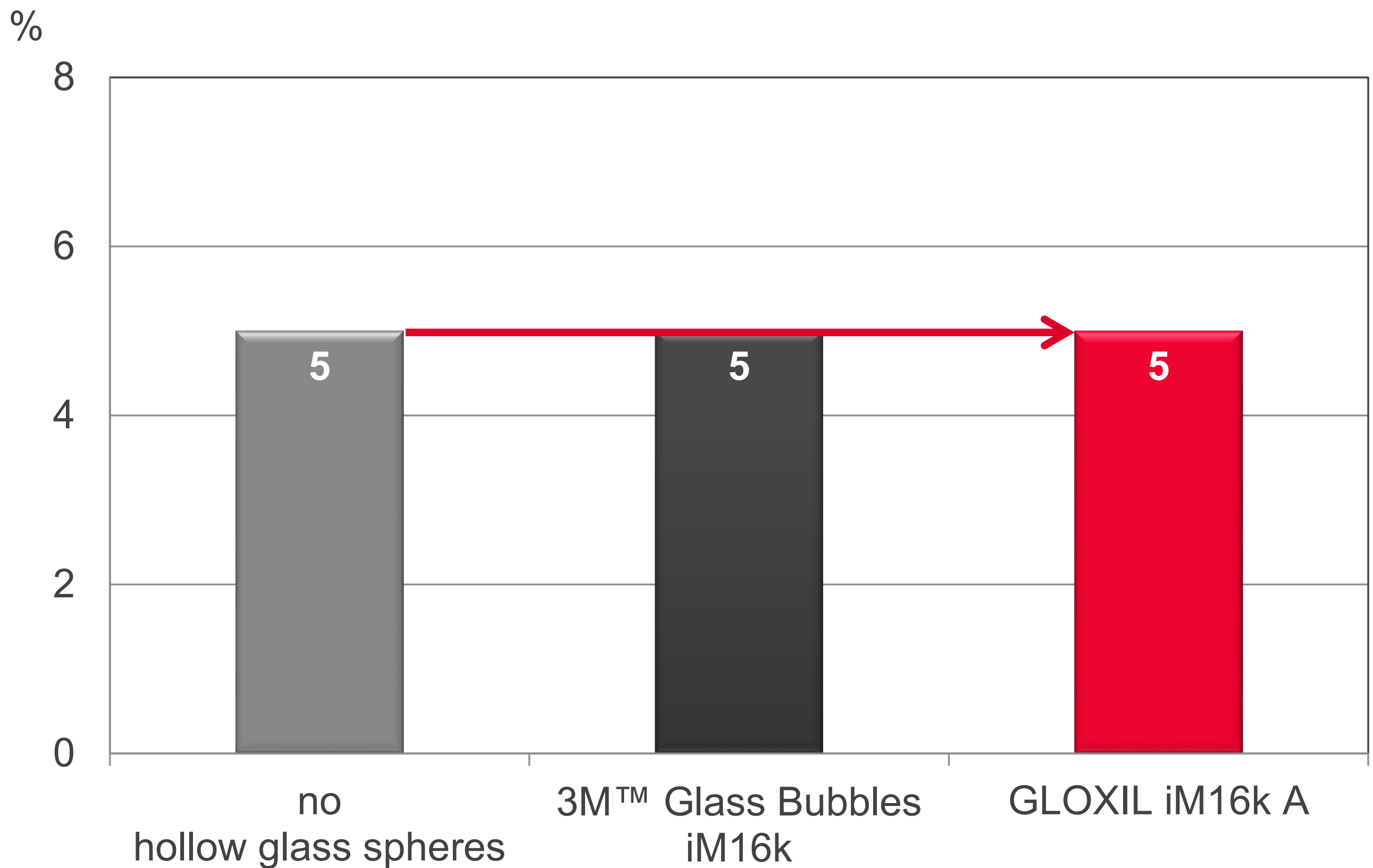

4 % m/m = 10 % v/v

Flexural Strength

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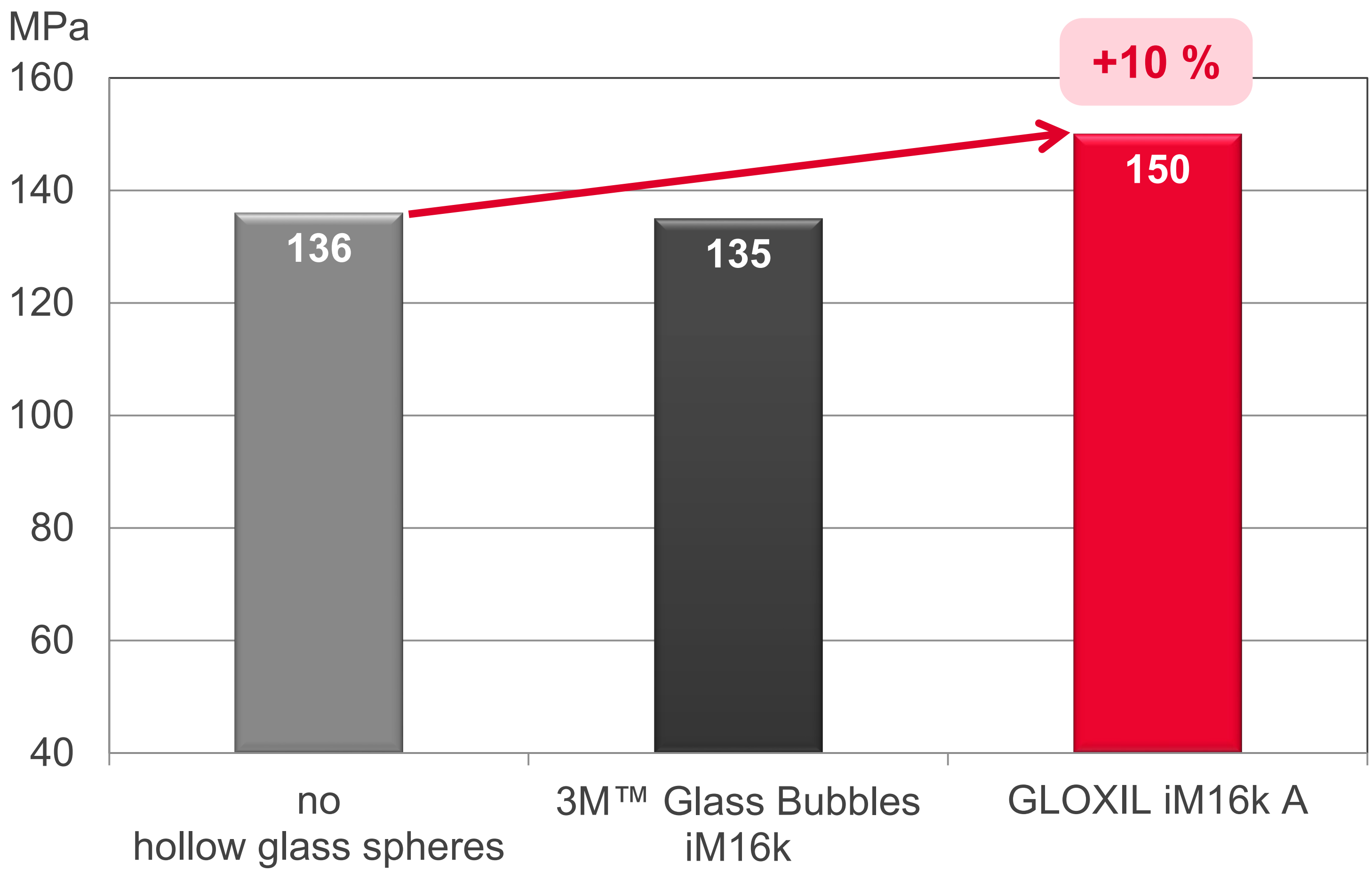
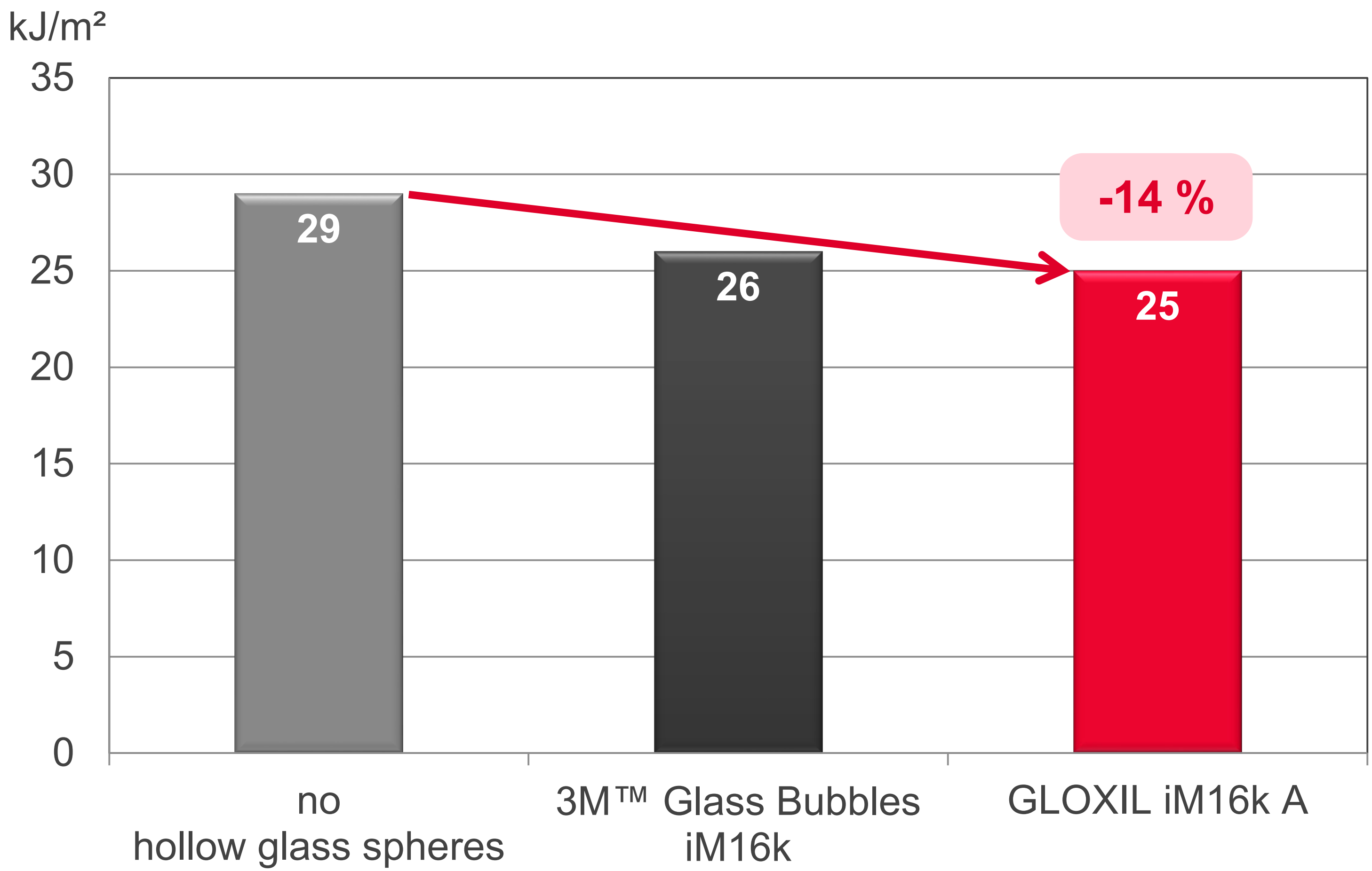


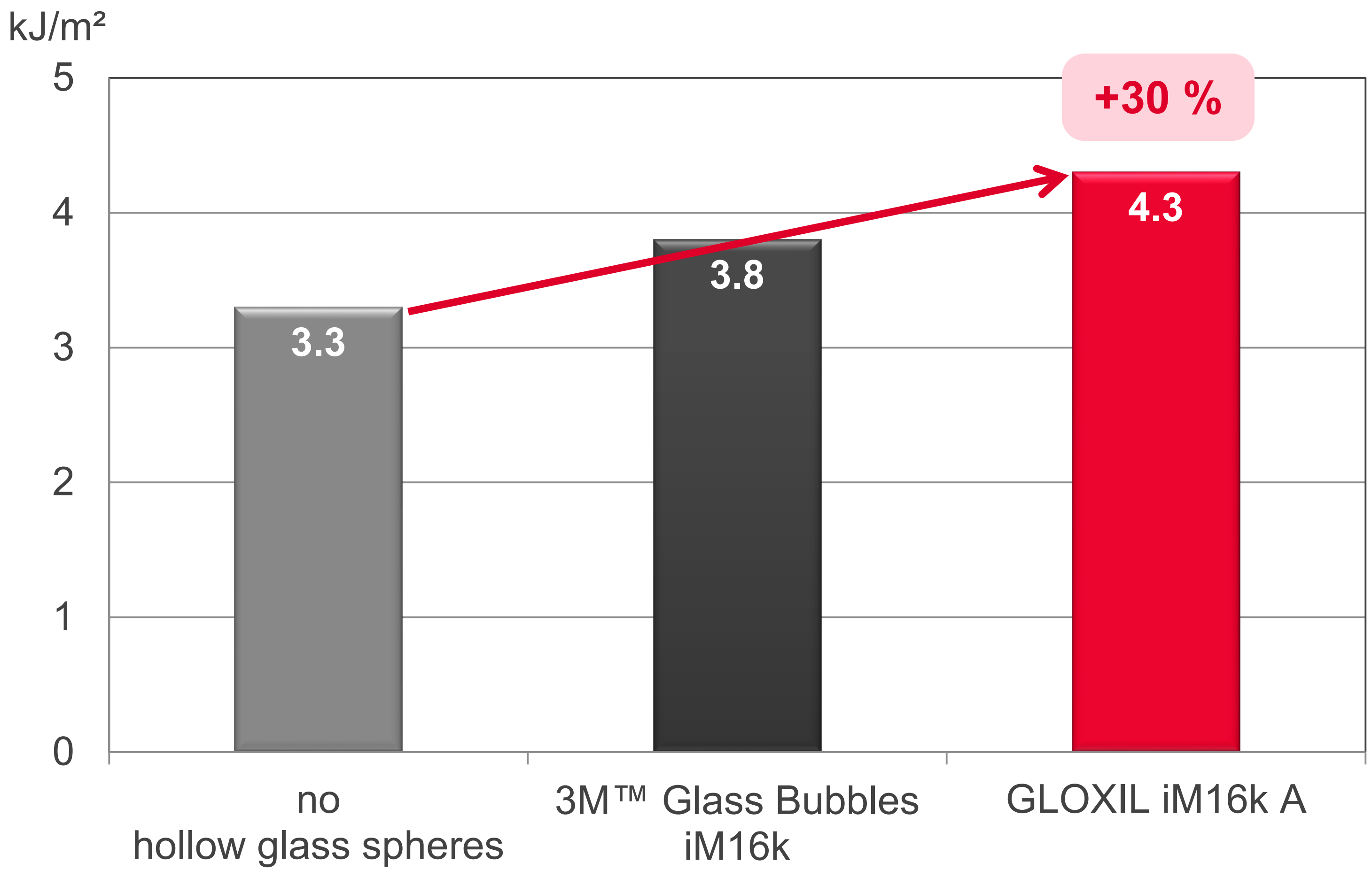
4 % m/m = 10 % v/v

Impact Strength Charpy



4 % m/m = 10 % v/v

Notched Impact Strength Charpy



4 % m/m = 10 % v/v

Summary
PA6 GF15 + Glass Bubbles

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GLOXIL iM16k A as an additive to PA6 GF 15 shows in comparison to PA6 GF15 without hollow glass spheres:

➢ Slightly lower impact strength

• Slightly reduced density and thus weight saving potential

\+ Increase in stiffness (tensile modulus and flexural modulus)

\+ Increase in tensile strength with unchanged tensile strain at break

\+ Increase in flexural strength

\+ Increase in notched impact strength

→ Objective achieved: higher stiffness without increase in density/weight and good mechanical properties

\+ Expectation: improved scratch resistance

PP Copolymer
Compound Formulations

Objective:
Density / weight reduction and still good mechanical properties

PP Compound Copolymer Bormod™ BF970MO Borealis MFR 20 g/10 min (230 °C, 2.16 kg)		
3M™ Glass Bubbles iM16k	0 to 25 % (m/m) 0 to 40 % (v/v)	---
Scona TPPP 2112 GA PP-g-MAH, approx. 1 % MAH, Byk	---	5 % (m/m)
GLOXIL iM16k A	---	0 to 25 % (m/m) 0 to 40 % (v/v)
Total	**100**	**100**

Data determined by 3M Advanced Materials Division, Special Additives Laboratory

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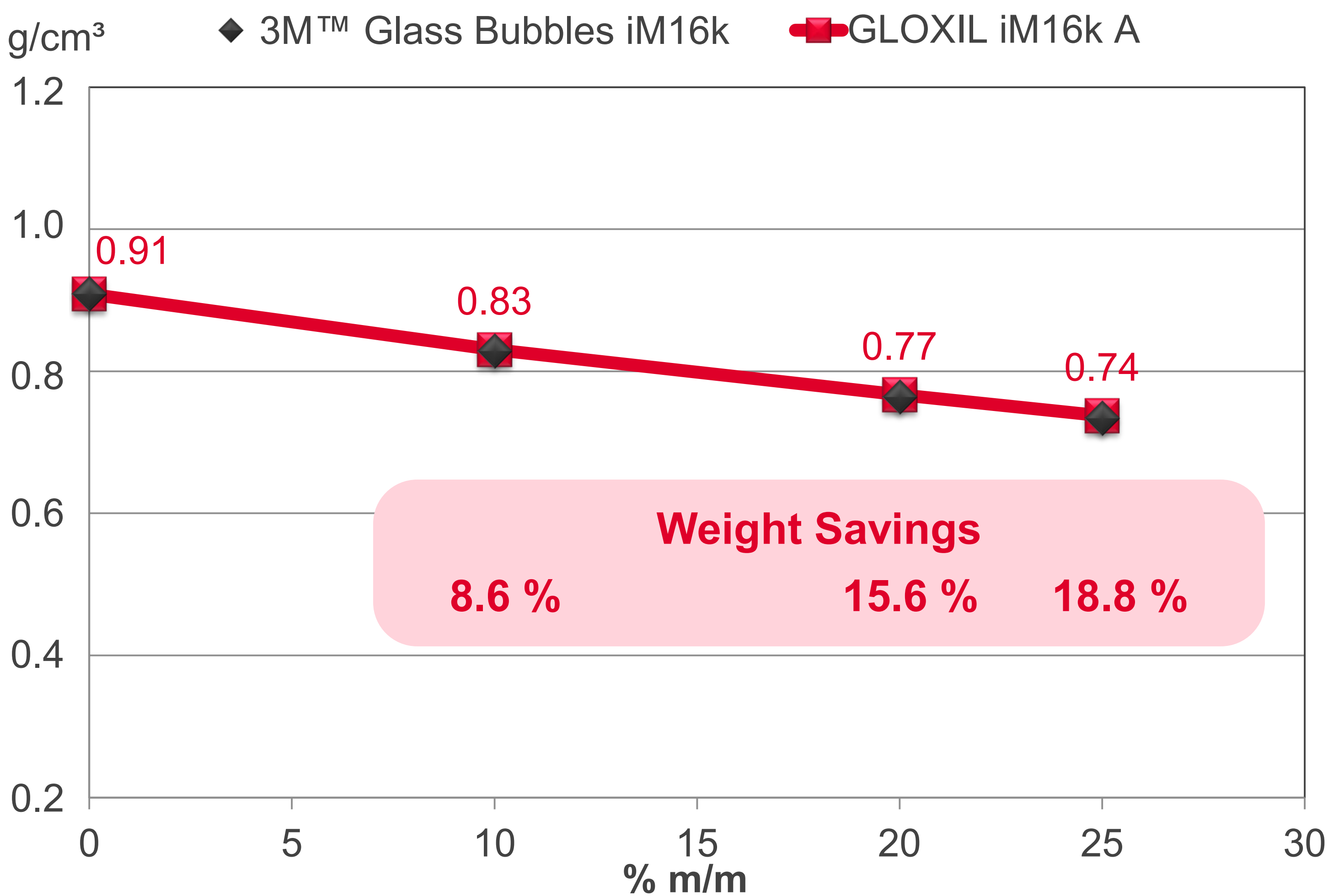
Density and Weight Reduction

measured; % m/m hollow glass spheres



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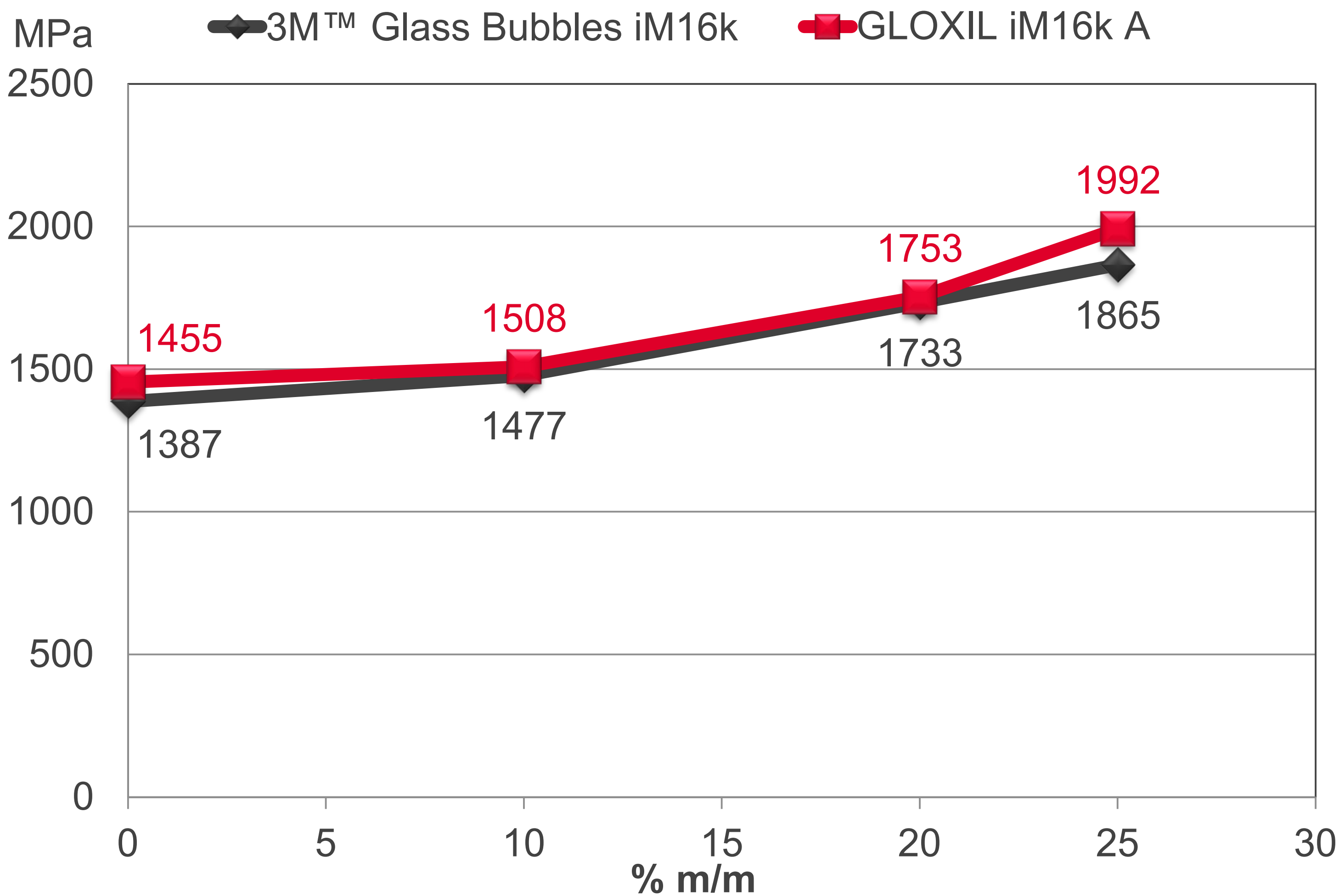

Flexural Modulus

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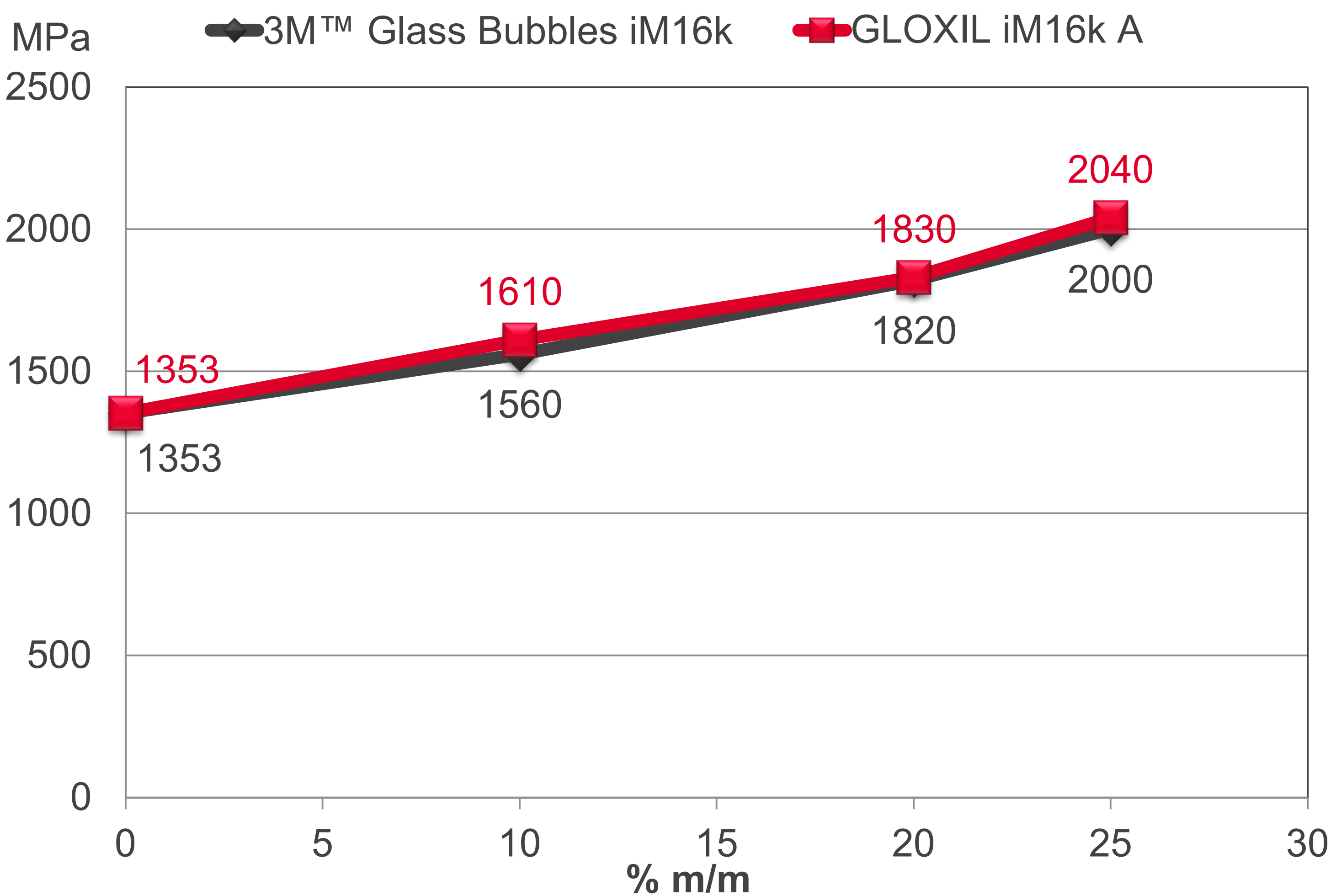
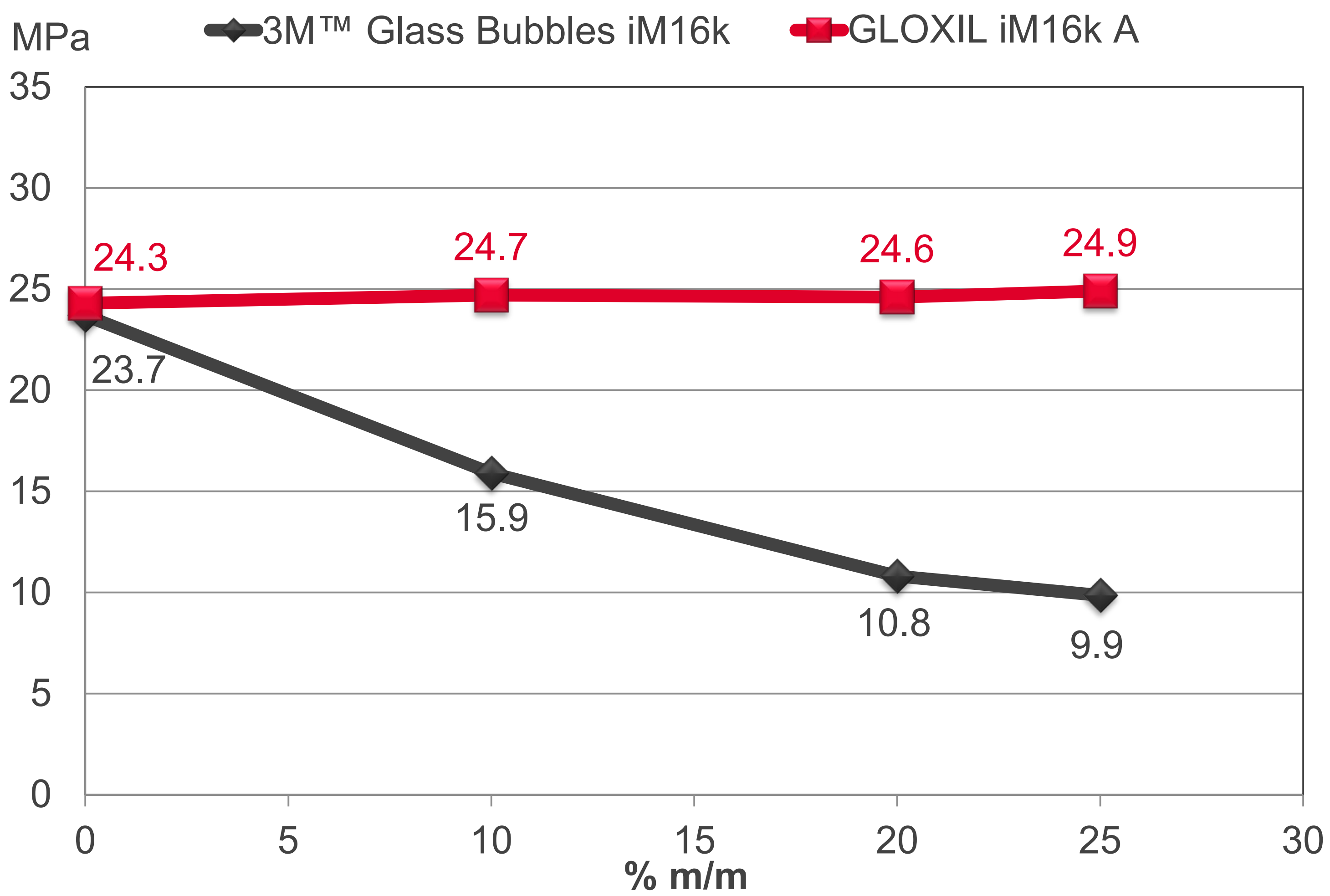


Tensile Strength



Flexural Strength

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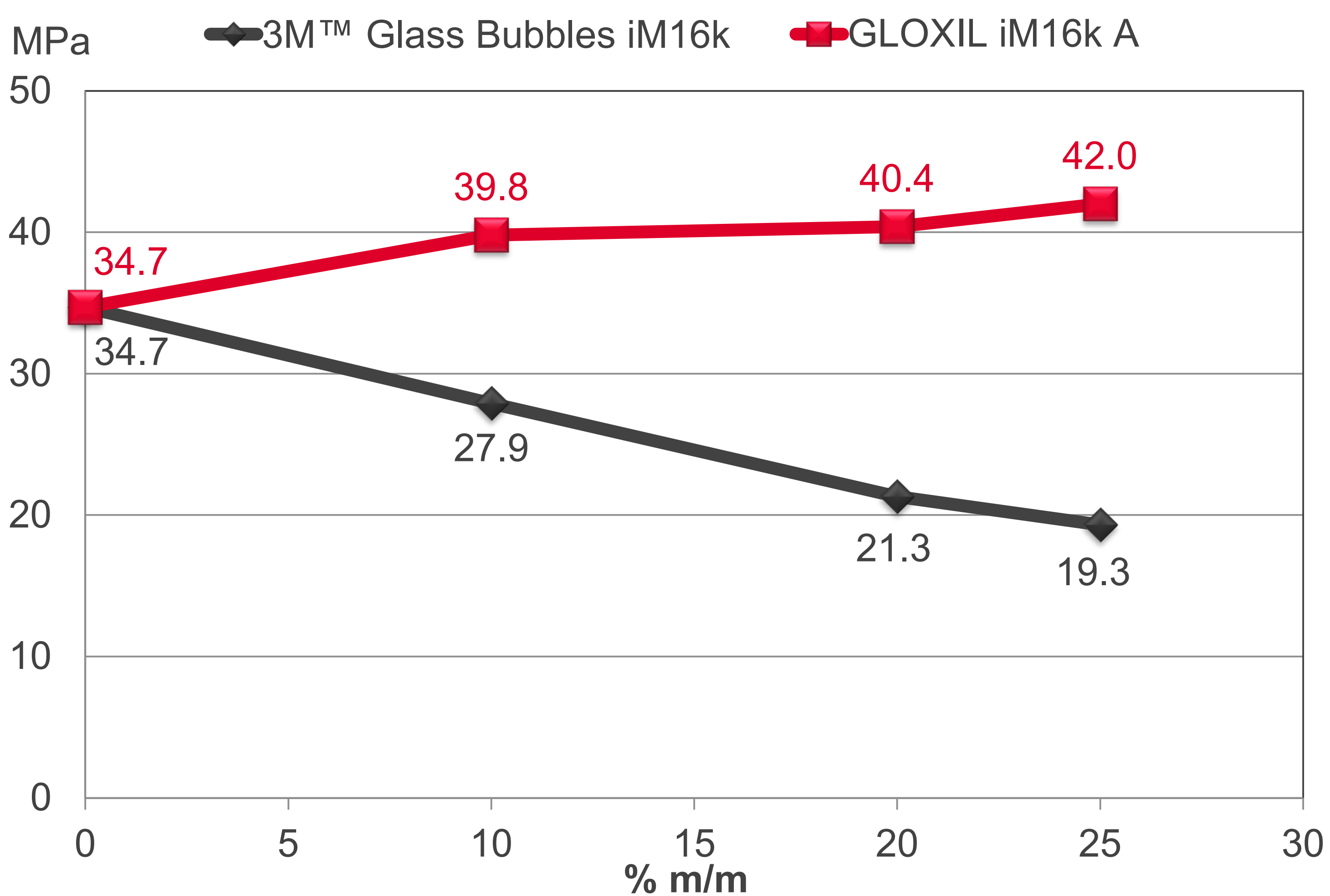

Impact Strength Charpy

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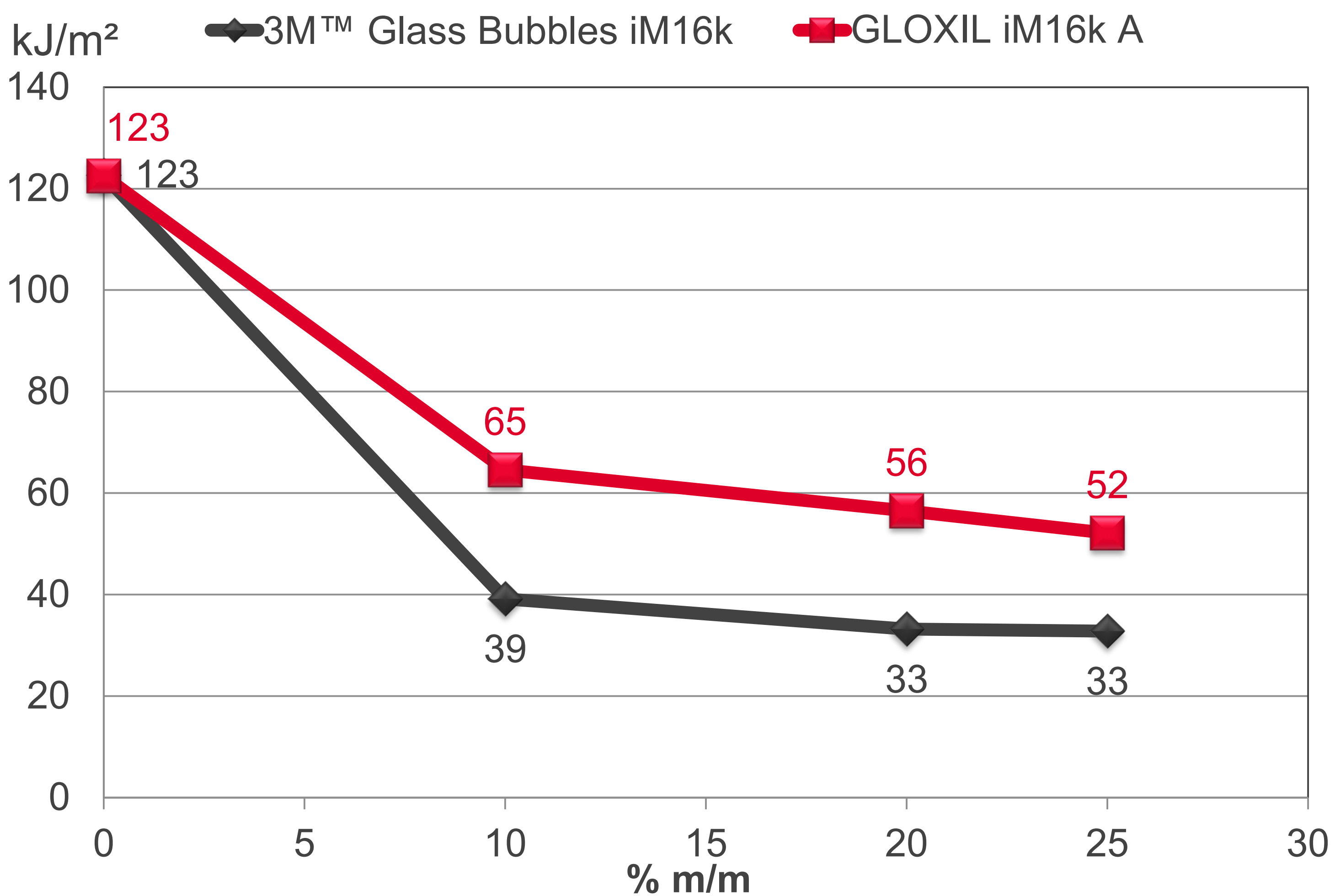

Notched Impact Strength Charpy

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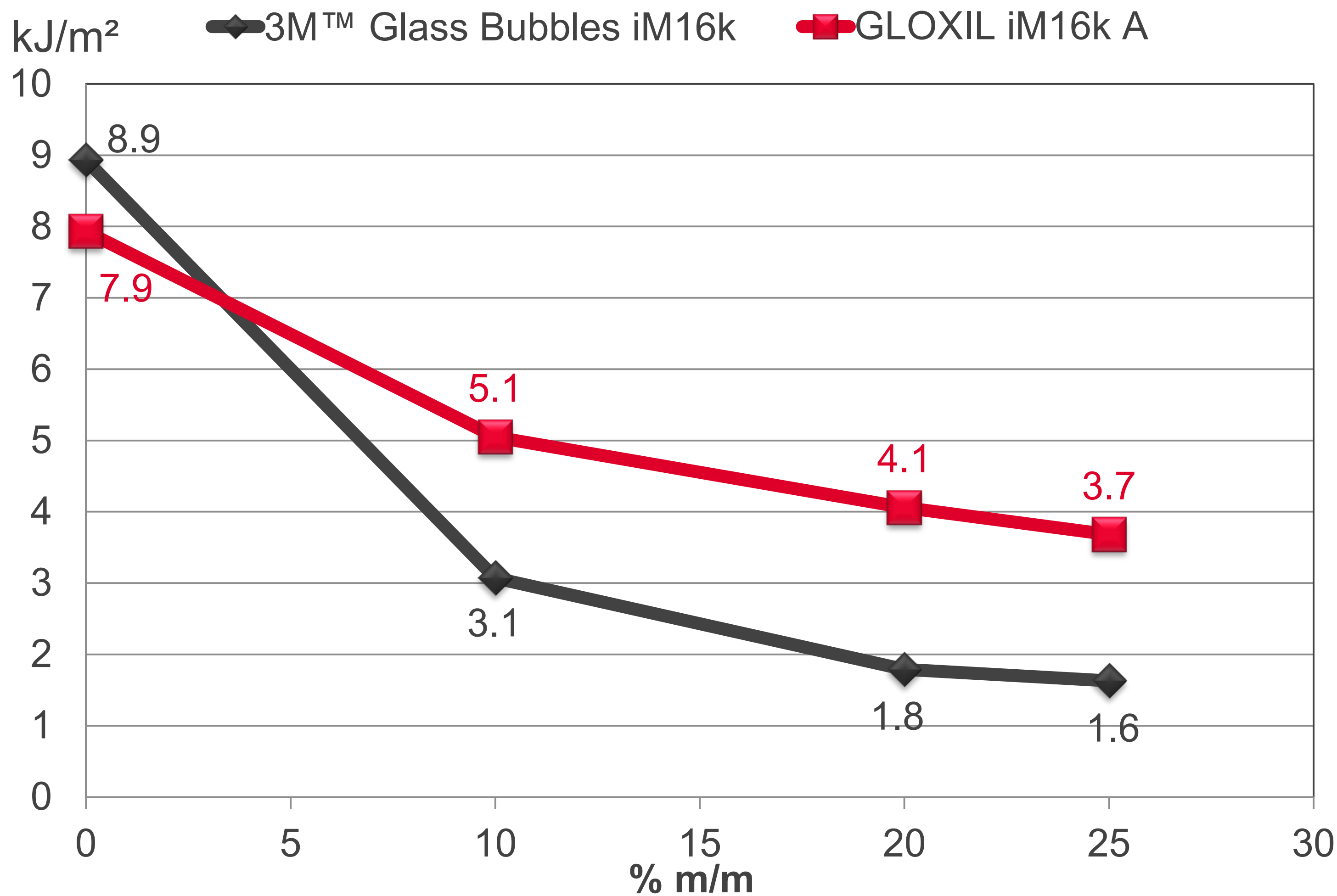

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PP Copolymer

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GLOXIL iM16k A shows in comparison to the untreated hollow glass spheres:

- Same density and thus weight saving potential
- Comparable increase in stiffness (tensile and flexural modulus)

+ Significantly higher tensile strength, largely independent of the filler content at the level of the unfilled PP copolymer
+ Significantly higher flexural strength, with increasing filler content even higher than the unfilled PP copolymer
+ Higher impact strength
+ Higher notched impact strength

→ Objective achieved:
density / weight reduction and good mechanical properties

+ Expectation: improved scratch resistance and reduced visibility of scratch marks

Note on efficient dosing of PP-g-MAH:
Concentration should be in the range of 10 to 15 % (m/m), based on the GLOXIL iM16k A dosage (applies to MAH content in PP-g-MAH of approx. 1 %, for other contents the concentration should be adjusted accordingly)

More Results PP
Talc / Glass Bubbles

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Objective:
Density / weight reduction and still good mechanical properties

PP Compound Copolymer Bormod™ BF970MO Borealis MFR 20 g/10 min (230 °C, 2.16 kg)					
Talc	20 % (m/m) 7 % (v/v)	10 % (m/m) 3 % (v/v)	10 % (m/m) 3 % (v/v)	10 % (m/m) 3 % (v/v)	---
Fusabond® P 613 PP-g-MAH 0.5 to 1 % MAH, Dow	---	6 % (m/m) 6 % (v/v)	6 % (m/m) 6 % (v/v)	6 % (m/m) 6 % (v/v)	5 % (m/m) 4 % (v/v)
3M™ Glass Bubbles iM16k	---	5 % (m/m) 10 % (v/v)	---	---	---
GLOXIL iM16k A	---	---	5 % (m/m) 10 % (v/v)	5 % (m/m) 10 % (v/v)	10 % (m/m) 18 % (v/v)
Infuse™ 9000 Olefin Block Copolymer	---	---	---	10 % (m/m) 10 % (v/v)	---
Total	**100**	**100**	**100**	**100**	**100**

Data determined by 3M Advanced Materials Division, Special Additives Laboratory

Density and Weight Reduction

measured

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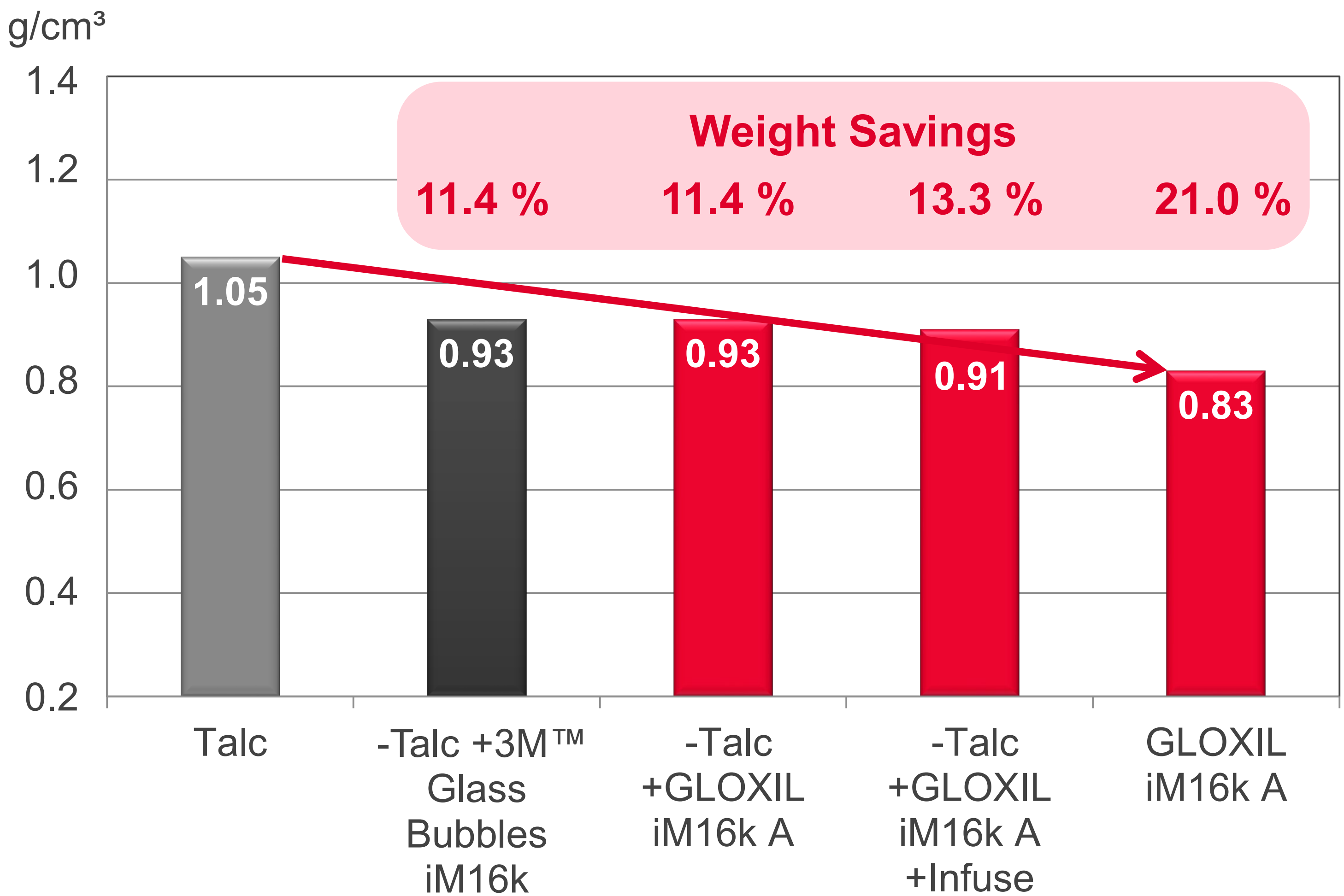
- SUMMARY



Tensile Modulus

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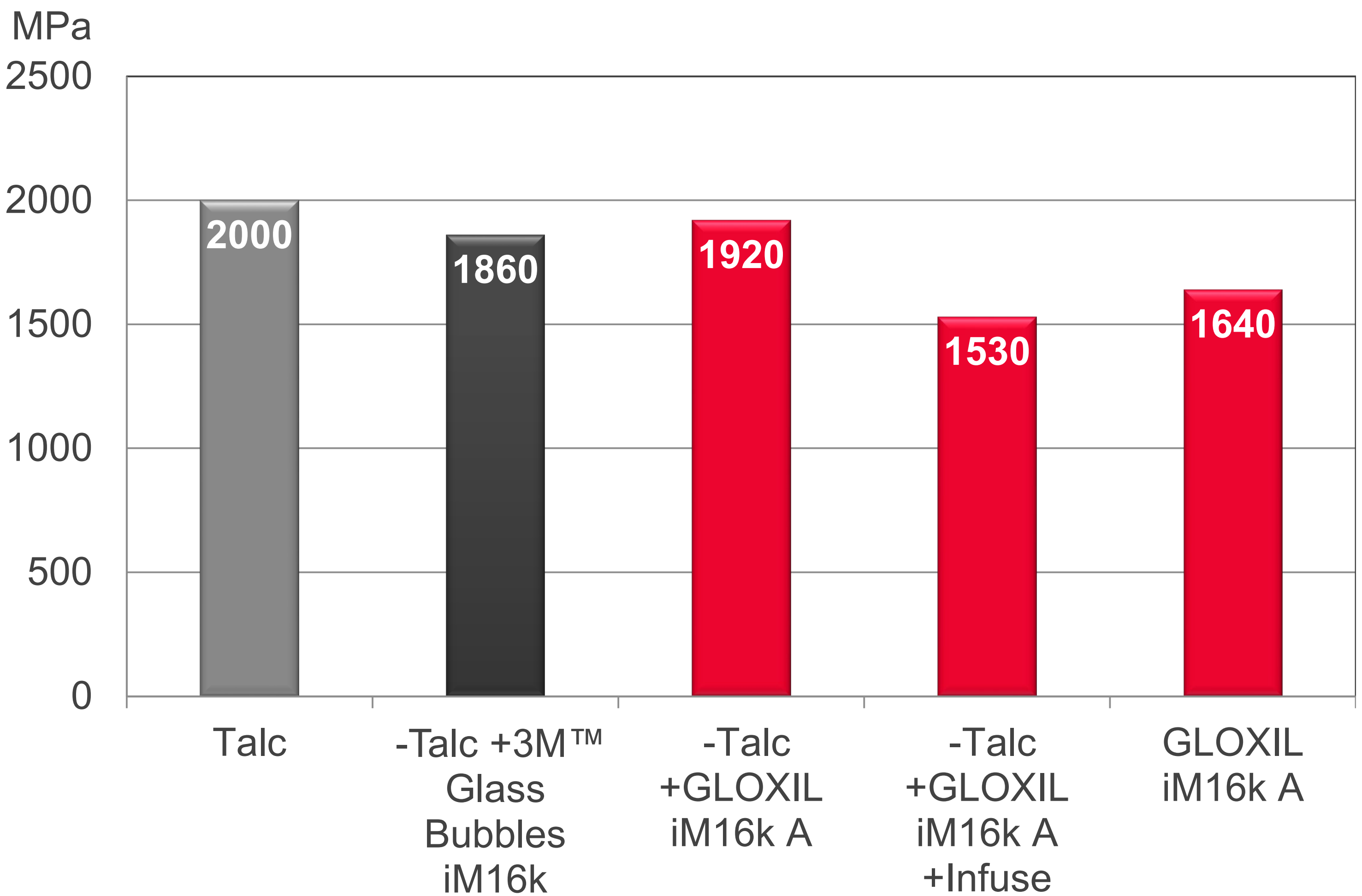

Yield Stress

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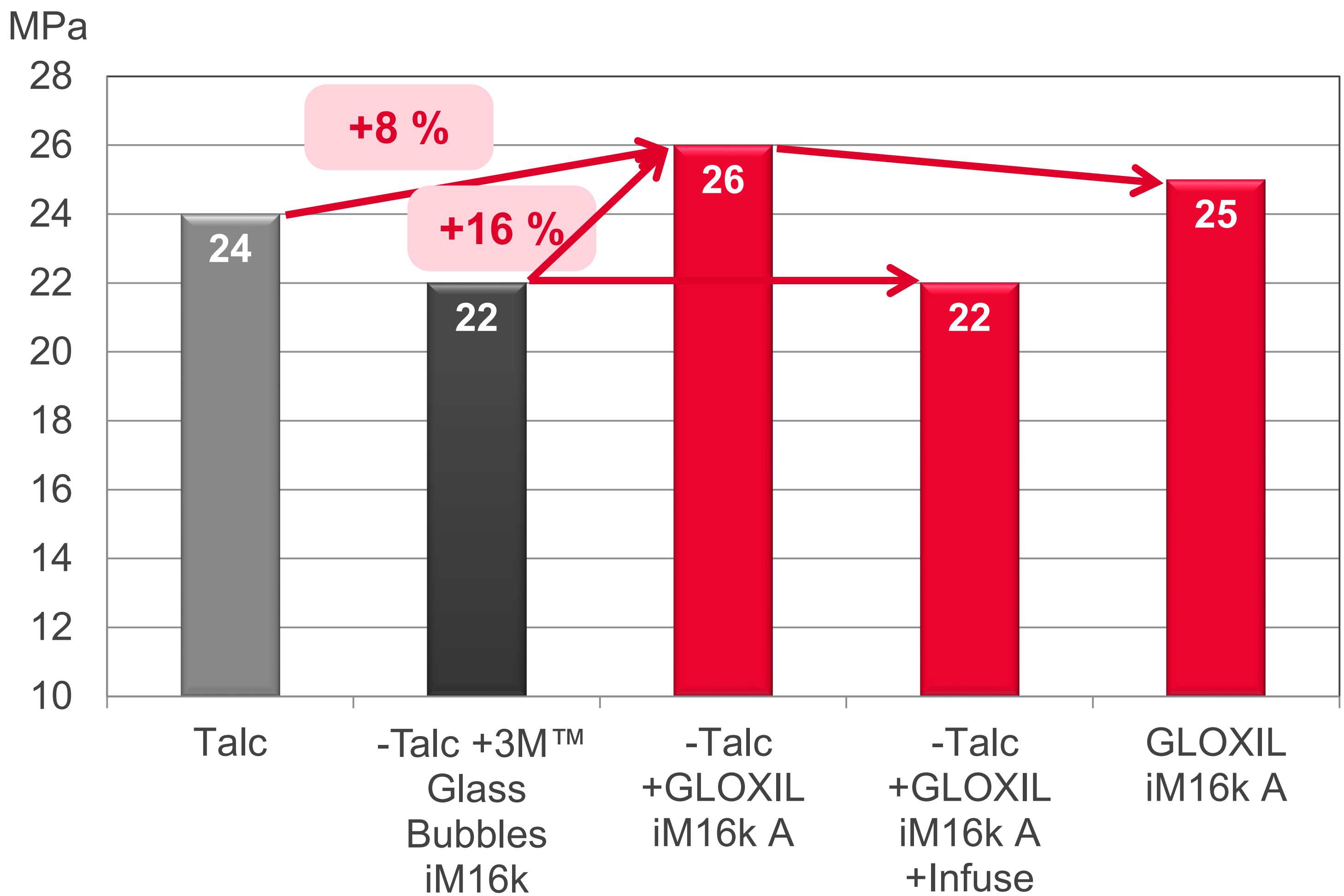

Impact Strength Charpy

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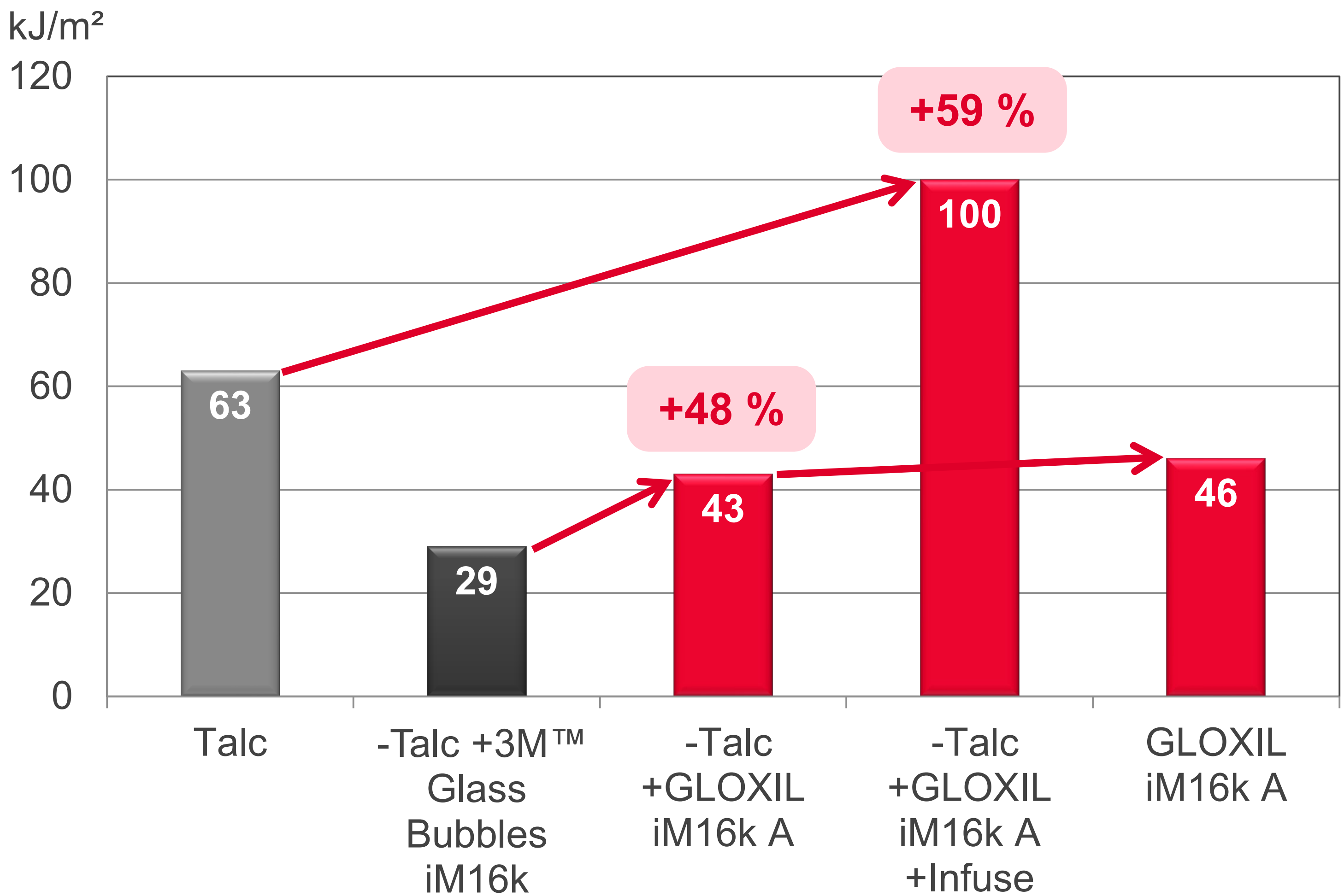

Notched Impact Strength Charpy

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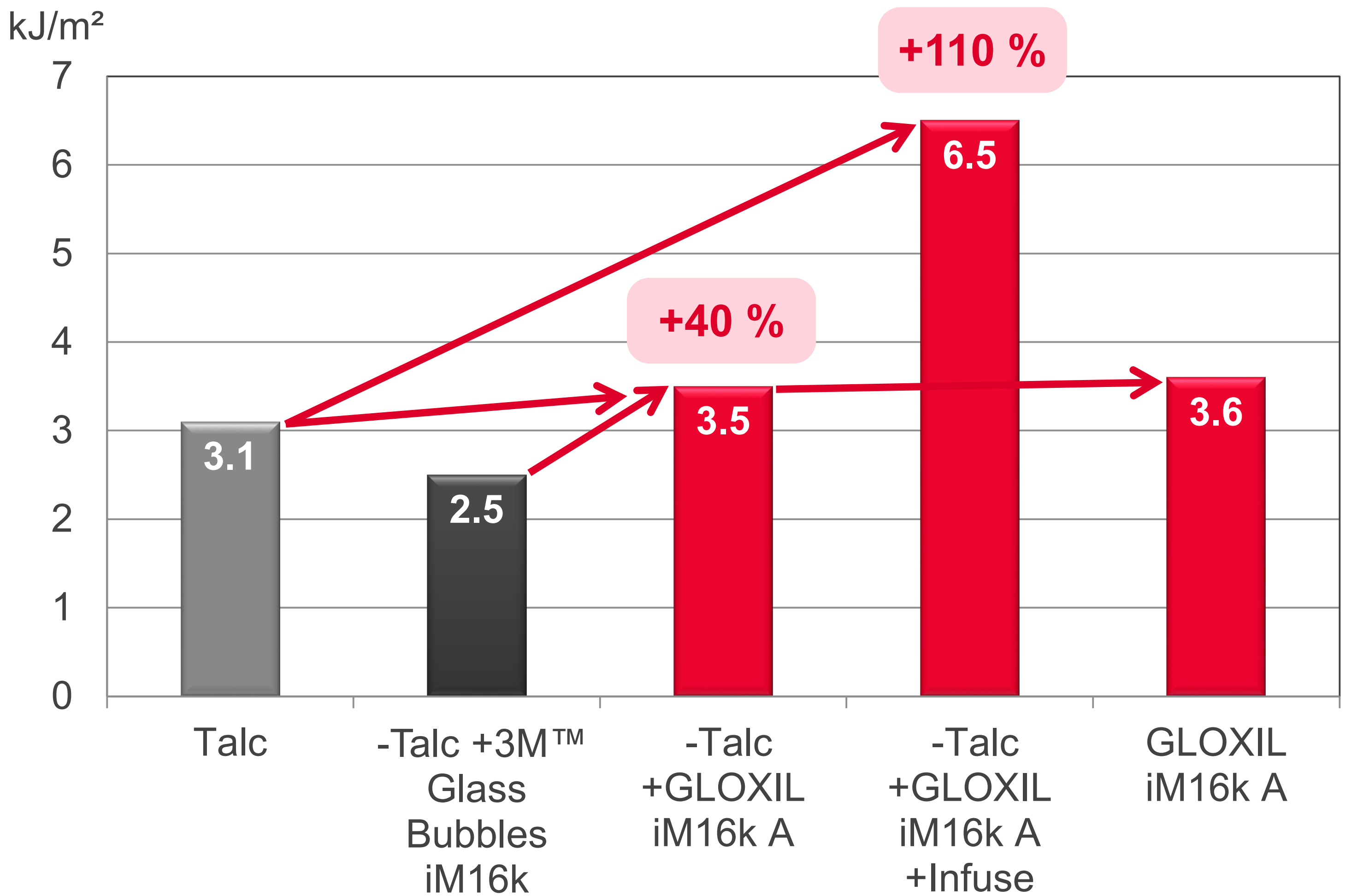

Summary PP Copolymer Talc / Glass Bubbles

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GLOXIL iM16k A shows **as partial and full replacement of talc** compared to PP Copo T20 without hollow glass spheres:

- ➢ Full replacement: slightly lower stiffness
- Partial replacement: comparable stiffness

+ Reduced density / weight saving potential up to 21 %
+ Increase in yield stress (and thus potential for introduction of impact modifier)
+ Hardly any loss of yield stress despite impact modifier
+ Comparable yield stress at full replacement
+ Increase in impact strength, especially with addition of impact modifier
+ Increase in notched impact strength, especially with addition of impact modifier
+ Comparable notched impact strength at full replacement

→ Objective achieved:
density / weight reduction and good mechanical properties

+ Expectation: improved scratch resistance

Summary Overall

GLOXIL iM16k A shows in comparison to the untreated hollow glass spheres:

- Same density and thus weight saving potential
- Comparable increase in stiffness (tensile and flexural modulus)

+ Significantly higher yield stress or tensile strength, largely independent of the filler content at the level of the unfilled polymer
+ Significantly higher flexural strength, with increasing filler content in some cases even higher than the unfilled polymer
+ Higher impact strength
+ Higher notched impact strength

+ Various possibilities for compound modification with e.g. impact modifiers without loss of other properties

+ Expectation: improved scratch resistance

We supply material for good ideas!

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