

Innovations in Engineering Plastics & Composites for Solar Applications to reduce costs and improve performance

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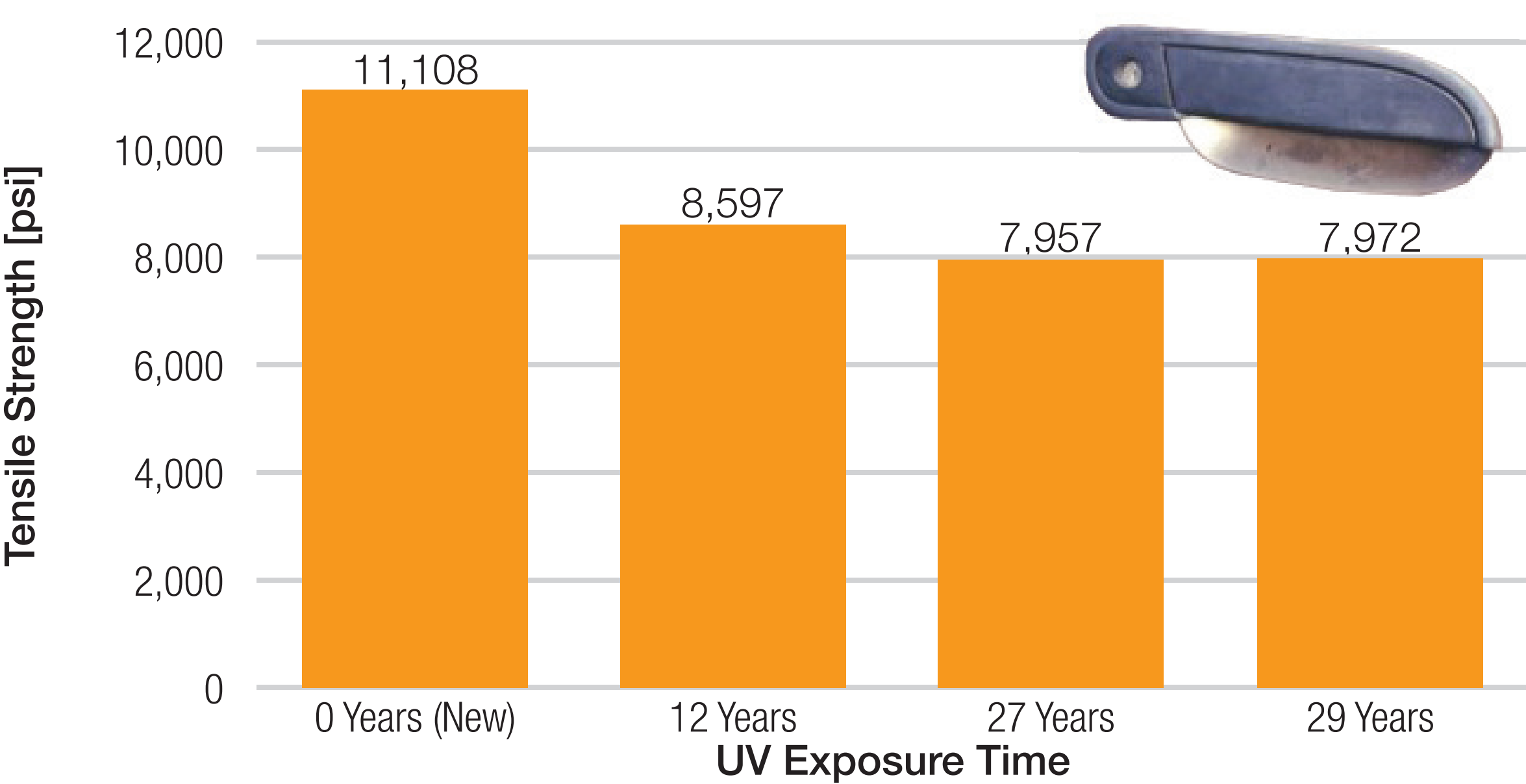
Objective:

- Results of new innovations and research ongoing at BASF Performance Materials are presented to help solar industry be more successful by developing Engineering Plastics solutions that reduce cost while delivering superior performance.
- Research data is presented on specific formulations of Polyamide 6, Thermoplastic Polyester, and Pultruded Polyurethane. A comparison of the data of these products vs. typical metals used in solar applications is shown. Certain solar product design requirements, such as UL2703 and others used in Commercial, Industrial flat roof products are also shown. All of these requirements are met by Polyamide 6 and thermoplastic polyester.
- Two specific examples of the solar products are shown, where these Engineering Plastics have been successfully used in (A) commercial flat roof mounting, and (B) a single axis tracker bearing for ground mount utility installations.

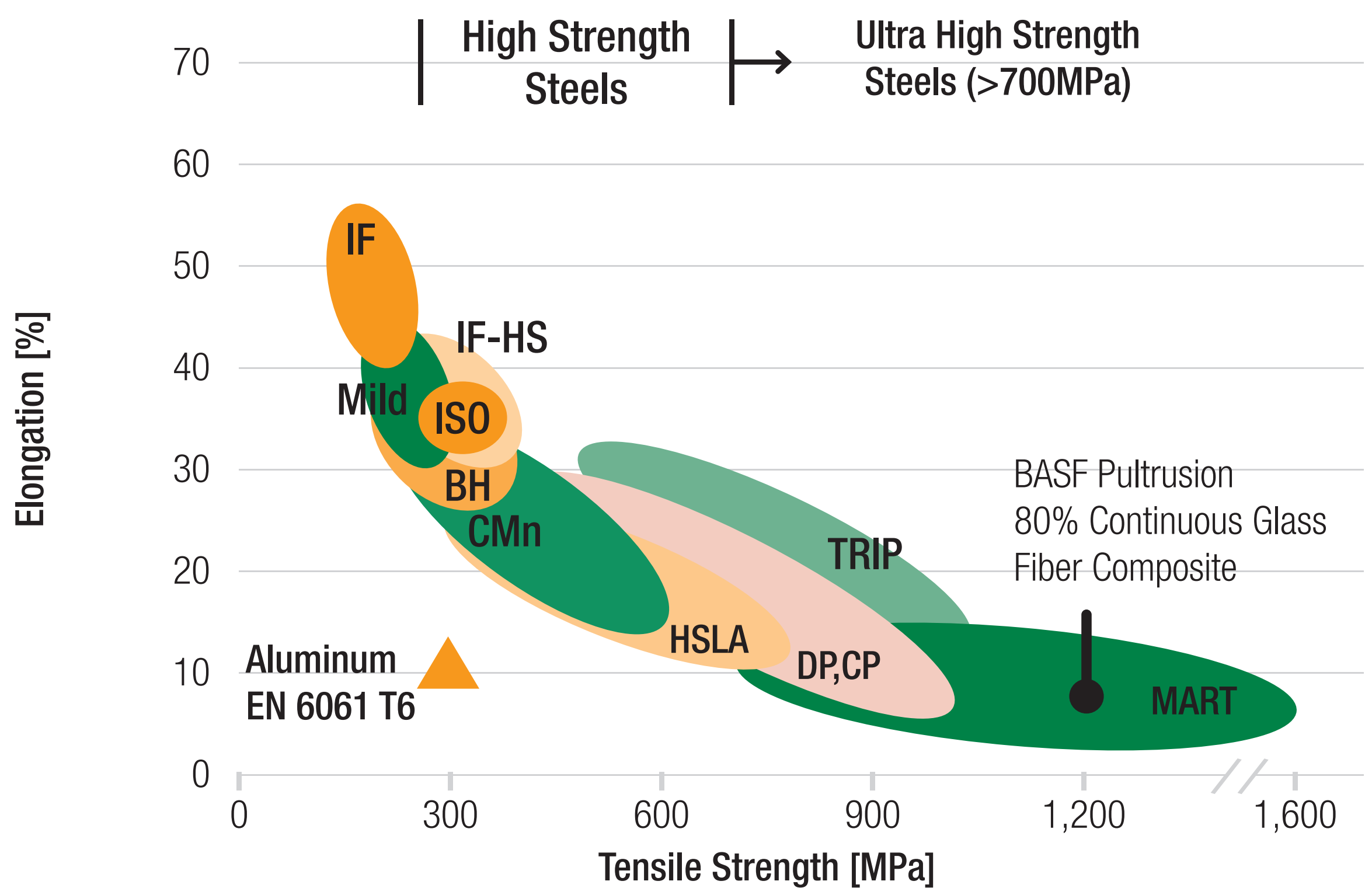
Performance Requirements for Solar: Metals vs. Engineering Plastics

Criteria	Aluminum and Galvanized Steel	Ultramid® PA6 30% glass	Ultradur® PBT 30% glass +HR
Tensile Strength -40°C to 95°C	++	+	+
Effect of Humidity	++	Δ	+
Heat Aging	++	+	+
Long Term UV Performance	++	++	++
Design Geometry Flexibility	+	++	++
Assembly Time on Roof	Δ	++	++
Corrosion Resistance	Δ	++	++
Stackable for Shipping	Δ	++	++
No Electrical Grounding with Frameless PV Modules	-	++	++
Total Cost	+	++	++

BASF Ultramid® 8267 HS BK106 Outdoor Weathering Performance



BASF Pultruded Polyurethane Elastocast® Metals data: Courtesy U.S. Steel



Polymeric material performance requirements according to Underwriters Lab (UL) 2703, ANSI Approved: 01/28/2015

UL 746C Ultraviolet Light Exposure

- 1000 hours of Xenon arc test or equivalent
- Average mechanical properties > 70% of original values

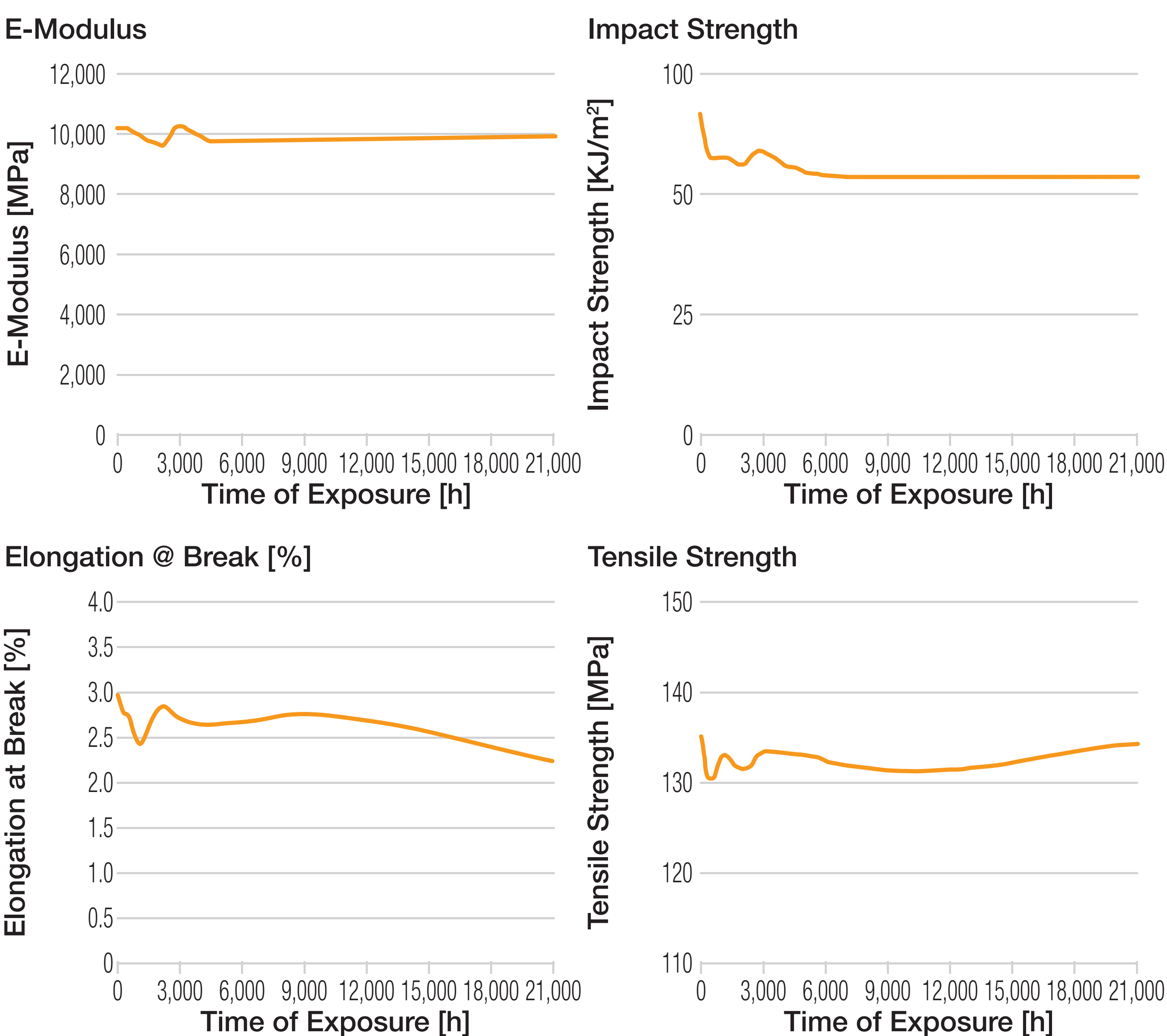
UL 746C Water Exposure and Immersion

- 70 ±2°C (158 ±4°F) for 7 days
- Average mechanical properties > 50% of original values

UL 2703 Section 7.4 Minimum Relative Temperature Index (RTI)

- Long term thermal aging at 95°C
- Average mechanical properties > 50% of original values

UV-Durability of Ultradur® PBT Xenon Arc 20 years Simulation



Other Design Considerations

- UV Stability for 30 years in Arizona Outdoor Conditions

Temperature and Humidity

- 40°C to 95°C
- Dry to 90% RH
- Wind Loading per ASCE up to 100 lbs./ft²
- Snow Loading per ASCE up to 55 lbs./ft²

Commercial Roof Mount and Ground Mount Tracker Bearing



Summary:

- The U.S. solar market is expected to grow rapidly with a variety of opportunities. Proposed innovative Engineering Plastics and Composite materials will help this growth while offering cost reduction, design flexibility and product performance improvement



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