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CASE STUDY

Expand polymer performance with new NANOALLOY® technology

Summary

Polymer: NANOALLOY® technology for **Amilan® S133 PA66 resin** and **Toraycon® 8207X01 PBT/PC resin.**

Applications: Instrument & electrical equipment housings, sporting goods, material handling, protection gear and equipment.

Key benefits: High impact resistance | Chemical resistance | Excellent mechanical strength

The Challenge

During conventional polymer alloying, performance properties of the individual polymers used in the alloy are reduced. For example, conventional PBT/PC alloys sacrifice the toughness of polycarbonate (PC) and reduce the chemical resistance of PBT. These reductions in properties bring limitations in the performance required to protect delicate instruments or equipment.

The Solution

NANOALLOY® technology is an innovative microstructure control technology developed by Toray. This technology can bring about dramatic improvement in characteristics compared to existing materials by minutely dispersing multiple polymers on a nano-metric scale.

The technology enables high performance and functionality in polymers which could not be achieved in conventional alloys of micron-metric scale (one millionth of a meter), and is a revolutionary technology whose basic patent, core process patents and utility patents are owned by Toray. Toray owns more than 100 patents related to NANOALLOY® technology.

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NANOALLOY® is a technology that forms a polymer alloy structure combining multiple polymers in the nano-metric scale.

The polymer alloy structure includes:

1. a structure that minutely disperses multiple polymers on a nano-metric scale

2. a structure that enables formation of a continuous 3-D structure that precisely aligns the polymers in a nano-metric scale by suppressing the self-organization effect where they combine on their own upon mixing polymers, and

3. a structure that includes "nanomicelle," several tens of nanometer sized particles with properties of the respective materials.

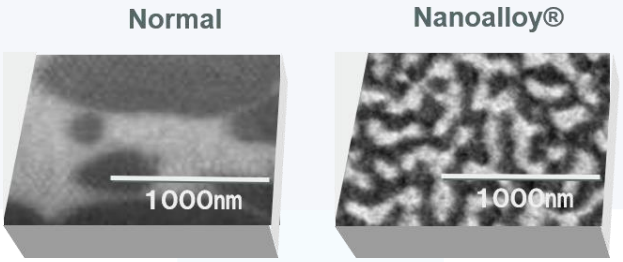

Figure 1. SEM Comparison for conventional polymer alloy vs NANOALLOY®

The key benefits offered by this technology include:

1. High impact resistance and chemical resistance
2. Excellent mechanical strength

High Impact Resistance and Chemical Resistance

Toraycon® 8207X01 Nano-co-continuous PBT/PC alloy has excellent impact and chemical resistance compared to conventional PBT/PC alloys. Impact resistance and chemical resistance is critical for instruments and electrical equipment housing applications. Figure 2 and Figure 3 shows that the impact resistance and chemical resistance of the PC/PBT NANOALLOY is significantly higher versus conventional alloys.

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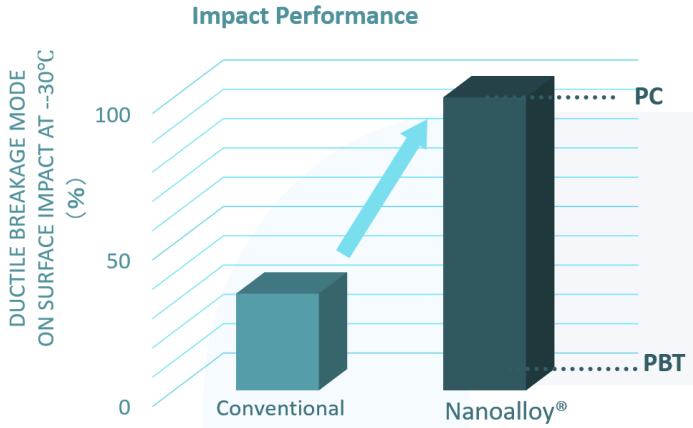

Figure 2. Impact resistance comparison for conventional alloys vs NANOALLOY®

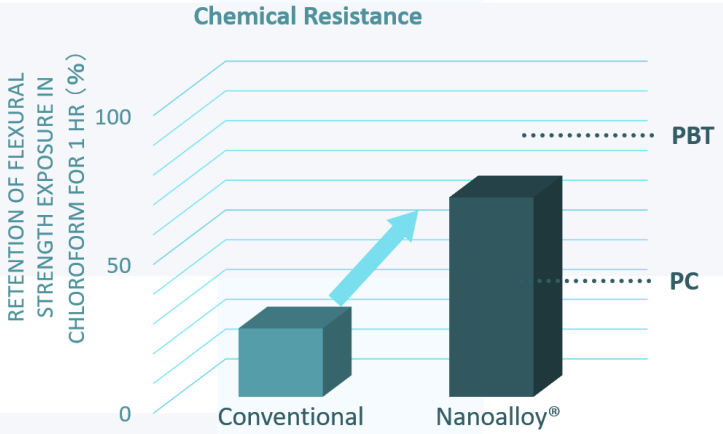

Figure 3. Chemical resistance comparison conventional alloy vs NANOALLOY®

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In Figure 4, we see a property comparison of convention PBT/PC alloy vs. NANOALLOY Toraycon® 8207X01 PBT/PC alloy. The NANOALLOY shows superior properties in chemical strength and hydrothermal resistance vs the conventional alloy. By greatly improving heat resistance temperatures and service life, NANOALLOY® technology can be used in applications that require high-performance plastics such as electrical/electronic components and automobile parts

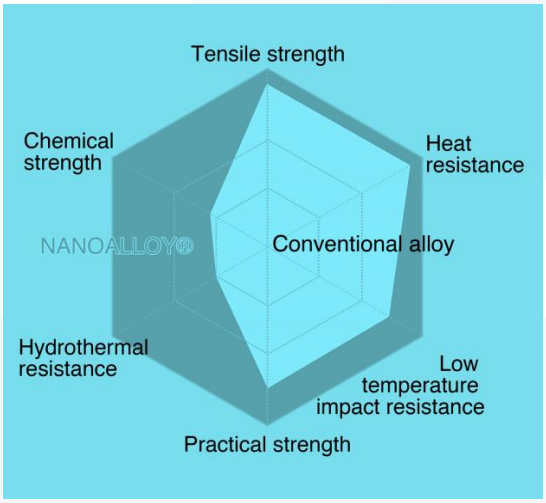

Figure 4. Property comparison of conventional alloy vs NANOALLOY® Toraycon® 8207X01 PBT/PC alloy

A property snapshot of the Toraycon® 8207X01 PC/PBT NANOALLOY® is shown in the table.

Property	Test method	Unit	Toraycon® 8207X01B
Specific gravity	ISO 1183	Kg/m3	1220
Tensile strength	ISO 527-1, -2	MPa	62
Tensile elongation	ISO 527-1, -2	%	109
Flexural strength	ISO178	MPa	95
Flexural modulus	ISO178	GPa	2.3
Charpy impact v-notched, 23 deg C	ISO179	kJ/m2	46
Charpy impact v-notched, -40 deg C	ISO179	kJ/m2	14
Heat deflection temperature 0.46 MPa/1.86 MPa	ISO75-2	deg C	103 / 120

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Excellent Mechanical Strength

Amilan® S133 PA66 (polyamide) resin, using NANOALLOY® technology, shows strength and rigidity under normal conditions. In Figure 5, the Amilan NANOALLOY demonstrates the unique property of changing its shape like rubber and absorbing shock when subject to external force such as a strong and swift shock as in a crash, which defies the conventional wisdom of existing polymers. This excellent mechanical strength is critical in such applications as sporting goods and material handling.

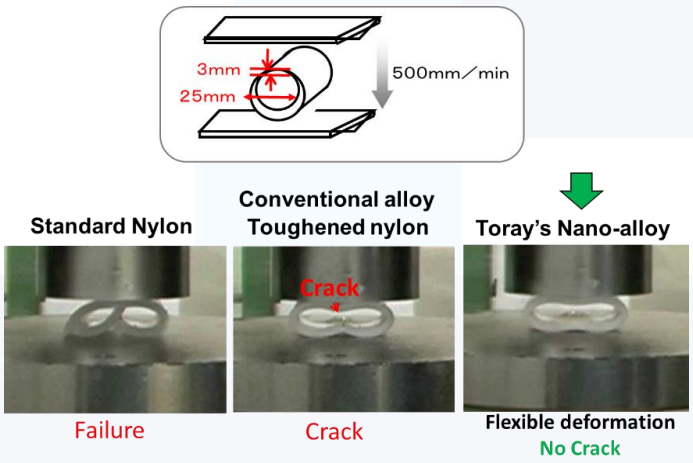

Figure 5. Comparison mechanical performance of standard nylon, conventional nylon alloy and NANOALLOY® Amilan S133 PA Resin

In Figure 6, we see a property comparison of convention alloy vs. NANOALLOY Amilan Polyamide. The NANOALLOY shows superior impact properties.

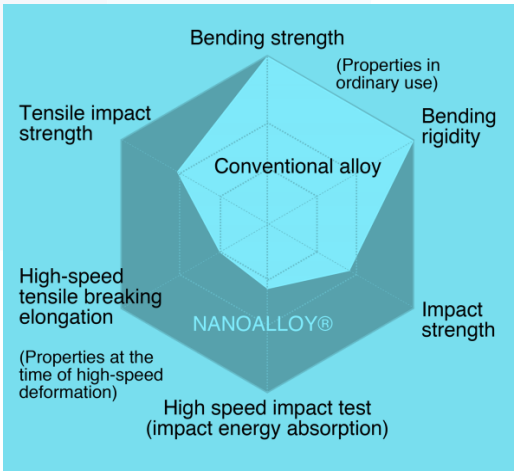

Figure 6. Property comparison conventional nylon alloy and NANOALLOY® Amilan Polyamide

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A property snapshot of the Amilan® S133 PA66 NANOALLOY® is shown in the table.

Property	Test method	Unit	Amilan® S133 PA
Specific gravity	ISO 1183	Kg/m3	1075
Tensile strength @23 deg C	ISO 527-1, -2	MPa	43
Tensile elongation at break 23 deg C	ISO 527-1, -2	%	>80
Flexural strength at 23 deg C	ISO178	MPa	58
Flexural modulus at 23 deg C	ISO178	GPa	1.5
Charpy impact v-notched, 23 deg C	ISO179	kJ/m2	105
Charpy impact v-notched, -40 deg C	ISO179	kJ/m2	15
Heat deflection temperature 0.46 MPa	ISO75-2	deg C	85
Heat deflection temperature 1.86 MPa	ISO75-2	deg C	55

More Properties and Application Examples

Shock resistance

By improving the flexibility under high velocity impact as well as shock absorbing and restoration properties of polymers, the technology enables long-term use of plastics, which until now have been treated as disposable, and it is also expected to improve human safety in protector applications.

Application examples

Golf clubs (shafts), tennis and badminton racket frames and strings, bicycles, fishing rods, bats, sports protectors, automobile exteriors (shock absorbing materials), safety helmets, mattress and flooring materials, etc.

High flowability and improvement in impact allows for thinner walls and productivity savings

NANOALLOY® technology improves the flowability of polymer in the melt state, and not only enables thinner parts and product design with complex shapes but also is expected to

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achieve energy savings through shorter molding cycles and lower molding temperatures while reducing greenhouse gases.

Application examples

Small precision parts such as telecommunication equipment connectors, etc.

Summary and next steps

NANOALLOY® technology is an innovative microstructure control technology developed by Toray. This technology can bring about dramatic improvement in characteristics compared to existing materials by minutely dispersing multiple polymers on a nano-metric scale. The technology enables high performance and functionality in polymers which could not be achieved in conventional alloys.

Want to learn more and request samples?

You can download technical data sheets and request samples for these NANOALLOY® grades here:

Toraycon® PBT/PC NANOALLOY®

Amilan® S133 PA66 NANOALLOY®