New thermo-opaque thermoplastics offer novel visual effects

Dr. Chris DeArmitt FRSC CChem describes the results of research on a new thermo-opaque thermoplastic. ThermoShift is a smart material that can change from opaque to transparent and back through changes in temperature.

Smart materials are well-known and used in varied applications. Their appeal lies in their ability to react to some change in the environment without the need for electronic support circuits, which in turn, makes for simpler, cheaper devices. A well-known example is that of thermochromic materials, which change colour with temperature. For example, masterbatches of thermochromic pigment can be added to thermoplastics to give parts that warn of temperature changes.

A type of smart material has been developed - thermo-opaque polymers - that can reversibly change transparency with temperature. The temperature of transparency can be adjusted within a range of –20°C to +90°C, with the window of transparency being approximately ±5-10°C relative to the temperature of maximum transparency. In addition to the temperature responsive behaviour, the material can be processed in the same way as normal thermoplastics. Mechanical properties are similar to those of transparent ABS, such as Terlux®.

Properties

The transmission and haze for a sample of material is shown in Figure 1. To the naked eye, the material is seen to be transparent from 50°C ±10°C.

The opacity shift effect is achieved using a patent-pending process which uses no low molecular weight additives. This means that the effect will not be lost due to extraction and there is no safety concern over migration of additives.

Applications

The new material shares the properties of transparent ABS (MABS) such as a good mechanical property balance, chemical resistance and colourability. This totally new material provides OEMs with the chance to differentiate their product with a new visual effect. The opacity change can be observed in natural (colourless) material or combined with colours. Recently this material was shown to a group of design professors and their students (Figure 3).

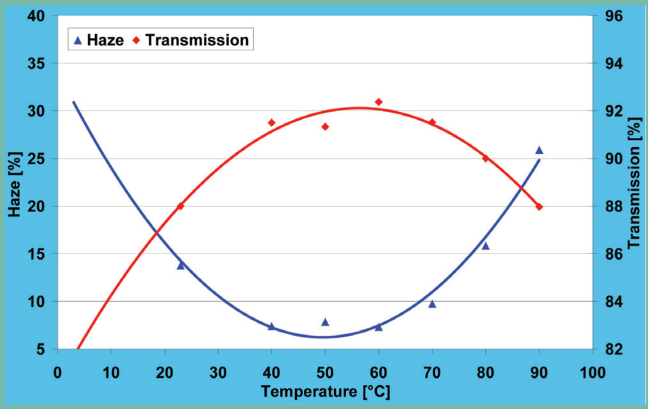

Figure 1:Variation of transmission and haze with temperature.

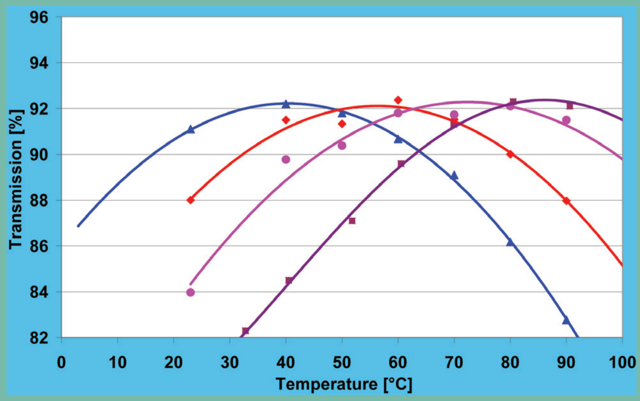

Figure 2:Variation of transmission for a set of four different ThermoShift materials.

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Figure 3: Presentation of ThermoShift for designers. The jug becomes transparent after heat is applied using the hair drier.

Table 1: Indicative mechanical properties*

Modulus (MPa)	~2000
Yield strength	~35
Unnotched Charpy (kJ/m^2)	~90
Notched Charpy (kJ/m^2)	~10-15
Puncture test (J)	~15-25
Vicat B (°C)	~91
MVR (ml/10 min)	~10-15

* Not to be used as a specification

Several ideas for new products were developed after the visit. At present several global OEMs are testing the material for use in household goods and appliances.

Conclusion

Smart materials are attractive because they provide property changes without the need for sensors and electronics. ThermoShift materials (patents pending) are a totally new family of smart material enabling new functionality and product differentiation. These materials are available with transparency temperatures in the range –20°C to +90°C and the opaque to transparent transition is fully reversible. The mechanical properties and colourability make the materials suitable for injection moulding, thermoforming and extrusion. These new materials are currently sampling and the decision to engage in full commercial production will depend upon demand.

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