

ThermoShift™: New Thermo-opaque Thermoplastics

Dr. Chris DeArmitt FRSC CChem
President – Phantom Plastics™
www.phantomplastics.com
Tel: +1 601 466 8342

Introduction

Smart materials have tremendous potential because they react to external stimuli without the need for sensors and electronics. This means that they can form the basis for cheap, simple and reliable systems that adjust automatically to their surroundings. Some examples of smart material systems include pipelines with smart insulation that automatically heats when the material becomes cold. As the material contracts, carbon black particles are concentrated together to form an electrically conductive path (so-called percolation) at which point current flows and heating takes place until the point where heating causes enough expansion to break the conductive pathway once more. Fun examples of smart systems include the famous Hypercolor t-shirts that shot to fame in the 80's. The t-shirts change colour when heated by the body or an external heat source. The colour changing effect is known as thermochromism. Although the commercial potential for smart materials is huge, in reality most remain mere laboratory curiosities due to issues with cost, scalability and safety. The new smart material presented here is unusual in two ways. Firstly, it is a new type of smart material. More importantly though, this new family of smart materials is inexpensive, scalable and safe, so it can be used in large scale commercial applications without issue.

The new smart material changes transparency with temperature and the effect is infinitely reversible. We have dubbed this new effect thermo-opacity. The temperature at which the material becomes transparent may be selected to be anywhere from -20°C all the way up to 80°C. The transition from opaque to transparent takes place over a relatively wide temperature range so you do not have to hit the exact temperature in order to see the effect.

Properties

The transmission and haze for one grade of the material is shown (Figure 1). To the naked eye, this material is seen to be transparent from 50°C ± 10°C. At the point of maximum transparency the material is very clear, like transparent ABS, polystyrene, PET and other well-known transparent plastics. The thermo-opaque effect will be correspondingly weaker in very thin sections, below around 1 mm, so it is recommended to use ThermoShift in thicker walled parts or it can be as a window in a larger part.

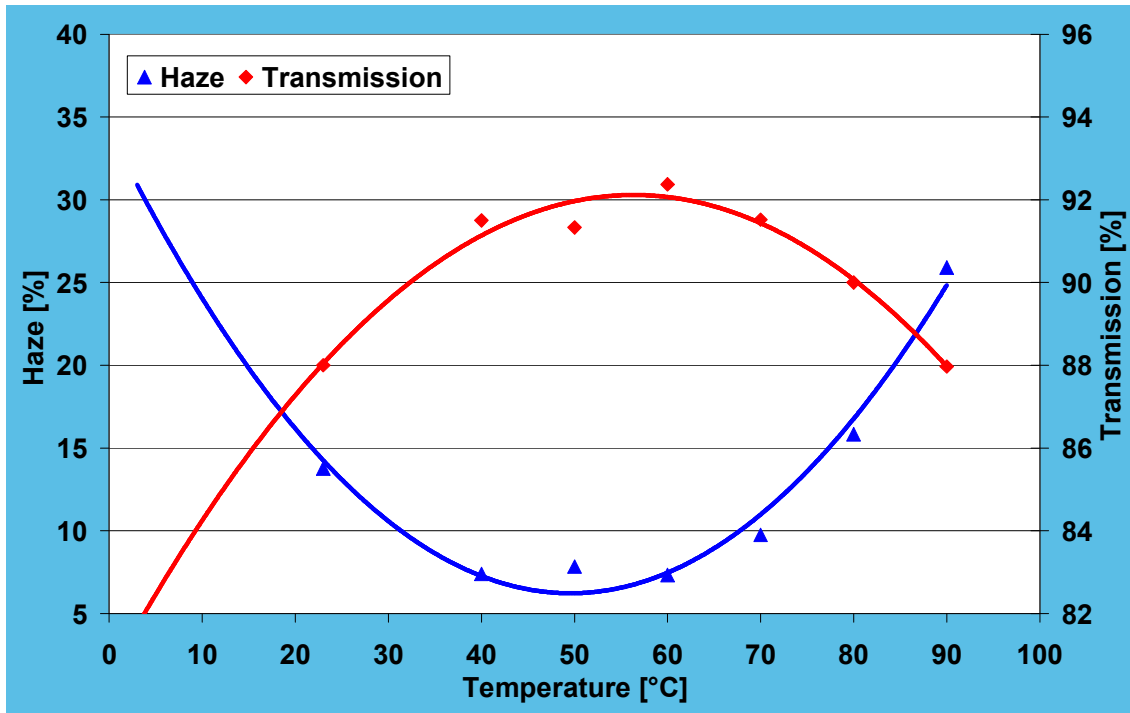


Figure 1 Variation of transmission and haze with temperature

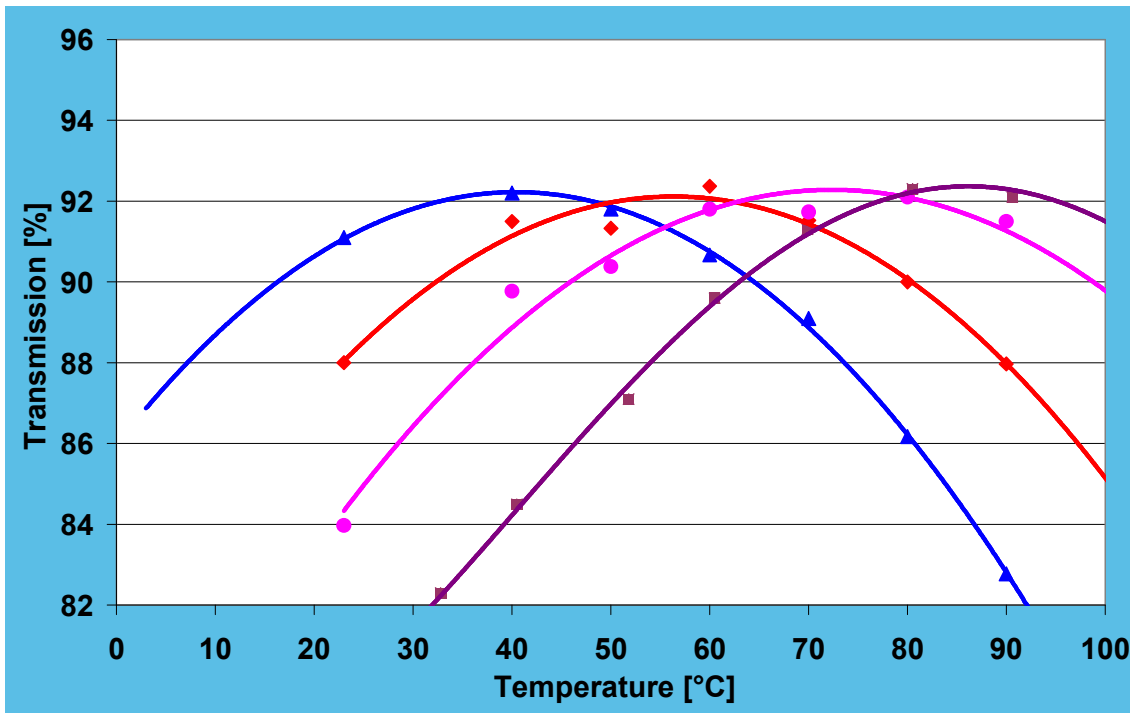


Figure 2 Variation of transmission for four different ThermoShift™ grades

The opacity shift effect is achieved using a patented method which uses no low molecular weight additives. This means that the effect will not be lost due to extraction and there are no safety concerns over migration of additives.

Modulus (MPa)	~2000
Yield Strength (MPa)	~35
Elongation to Break	~12%
Unnotched Charpy (kJ/m²)	~90
Notched Charpy (kJ/m²)	~10-15
Puncture test (J)	~15-25
Vicat B (°C)	~91
MVR (ml/10 min)	~10-15

Table 1 Indicative mechanical properties (not to be used as a specification)

Applications

ThermoShift™ was not made merely for the sake of scientific curiosity, it was made upon the request of a major OEM who needed such a material but was unable to find anything on the market. They approached me, as I have a reputation for developing revolutionary new materials and I was able to develop the material to their specification which included demands for good chemical resistance, injection moldability, a transparency temperature around 55°C, no extractables and, of course, reasonable cost.

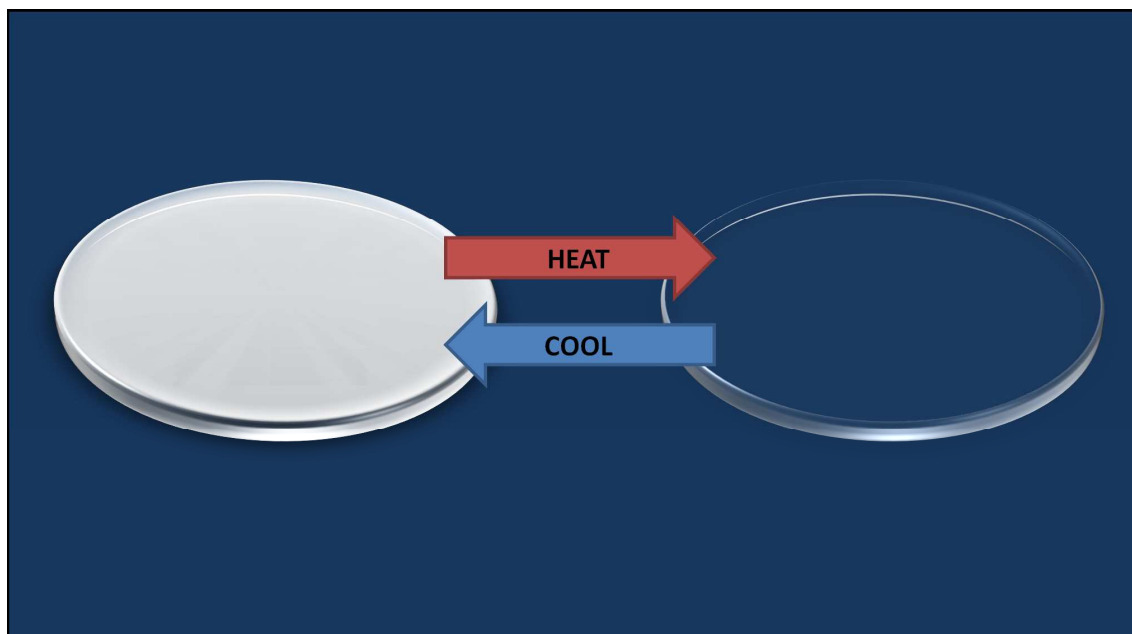
The new material was developed, tested and patented and because we could imagine all kinds of applications for it, we grew it into a family of materials with different transparency temperatures from as high as 80°C all the way down to -20°C. The present range of materials is based on an amorphous thermoplastic resin which gives processability, mold shrinkage and mechanical properties very much like the commodity plastic ABS. As everyone is familiar with ABS, the new material is a drop-in solution in existing molds and processes.

Phantom Plastics™ is working under NDA with some of the World's most well-known companies to commercialize ThermoShift™ in several different application areas. Naturally, the details of those development plans are confidential. Nevertheless, one can

imagine such a material would find use in all kinds of places from automotive, through household appliances all the way to novelty items. Industrial designers are captivated with the possibility to create special lighting effects whereby a ThermoShift™ lampshade enables the lighting to switch from harsh to soft as the opacity induced by the warm light bulb gives a frosted effect. Similarly, it can be used in many of the applications where thermochromics are used today to warn of extreme temperatures.

In order to bring this product to market, Phantom Plastics is proud to be partnered with Norner™ (www.norner.no) a World-class plastics R&D centre whose experts are able to support commercial development, production and market penetration of this new material. Norner were formerly a Borealis Skill Centre so they have tremendous skills and facilities and have developed quite a name for developing cutting edge materials such as their sustainable plastics made from carbon dioxide as a monomer.

The present material is not suitable for long periods at high temperature and will degrade and discolour if exposed to strong UV light. However, the UV can be easily blocked using an appropriate filter. If there is a demand for new versions with different mechanical properties, higher temperature performance or other specifications then it is possible to develop new grades based on customer requirements.



Picture 1 Pictorial representation of the transparency change effect

Conclusion

ThermoShift™ is a completely new, patented, type of smart material unlike anything else on the market. Not only does it display the ability to change from opaque to transparent reversibly but the temperature of optimal transparency may be tuned over a wide range from -20°C to 80°C. Due to excellent processability and mechanical properties, ThermoShift™ is a drop-in solution to OEMs looking for a product that stands out and designers looking for a new look. Check the Phantom Plastics™ website for more information and to see a movie of the material in action.