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pioneers in polymers

CHROMOGENIC POLYMERS

A further functionalization of polymeric materials will enhance their use and broaden their range of possible applications. Chromogenic polymers change their color by an outer stimulus, and therefore, they can easily visualize surrounding changes. According to the affecting stimulus different material classes are known:

- thermochromic materials – change of color by temperature variation
- thermotropic materials – change of transparency by temperature variation
- photochromic materials – change of color by light exposure
- piezochromic materials – change of color by an impact of pressure

Further materials are investigated exhibiting electrochromic, ionochromic or mechanochromic properties.

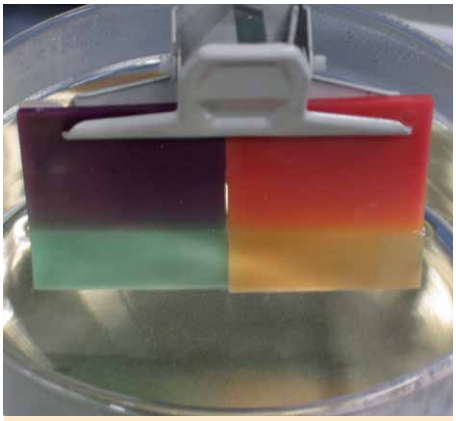
The R&D work of the Fraunhofer IAP meets the growing interest of industrial applicants in the field of chromogenic materials.

Thermochromic materials visualize temperature changes

The introduction of thermochromic properties into commodity polymers – thermoplastics, thermosets, elastomers, lacquers and coatings – is one feature of the current work. In this context, it is our goal to retain the material properties relevant to the application. This requires thermochromic additives which are stable in the polymer matrix as well as during the manufacturing processes with their strongly differing demands:

- heat and mechanical impact during the extrusion of plastics,
- thermal and chemical impact during the curing of thermosets or crosslinking of elastomers and
- attack of solvents and other chemicals during the drying and curing of lacquers and coatings.

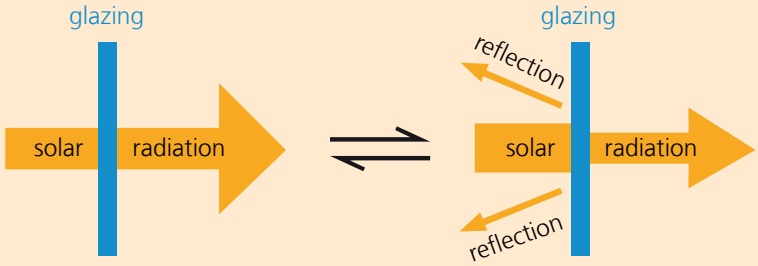
A broad range of different colors, switching temperatures and transitions with



Color change in injection-molded test pieces.

Intelligent glazing

Changing the transmittance in response to temperature



Scheme of thermotropic glazing.

reversible or irreversible color changes are possible. In principle, thermochromic additives can be integrated in different polymer matrices like thermoplastic films, duroplastic materials, etc.

An excellent example is the application of thermochromic materials as optical sensors in mechanical engineering. To avoid the overheating of moving machine parts color changing polymers can be used as an integrated warning system. They indicate transgressions of safe operating conditions, for instance by turning red to indicate a »red alert«. Once the fault has been corrected, the color transforms back into its original state.

Thermotropic materials contribute to more energy efficiency in buildings

Modern architecture is characterized by large-area glass facades creating a light and airy atmosphere inside a building. From an energy-saving point of view, a high amount of glass has pros and cons: In winter, solar light reduces the energy consumption for heating and artificial lighting. However, in summer, sun-drenched buildings heat quickly and require an immense effort for air conditioning and air circulation. In such cases, intelligent glass facades with thermotropic properties open up new perspectives.

Thermotropic glass systems consist of a layer containing either a thermo-sensitive resin or polymer film. By an increase of temperature induced by solar radiation, this thermotropic layer changes from transparent to opaque and a large part of the solar radiation is reflected by back scattering. Thus, the energy requirements for cooling can be reduced significantly.

Thermotropic films are of special interest due to its cost-efficient processing technology by extrusion.

Further investigations in our laboratories – including a variation of the switching temperature and experiments in different polymer matrices – emphasize the high potential of the concept for various fields of application.

Thermotropic glazing (off- and on-state).