Effect of color pigments on the hardness of thermoplastics at different temperatures

Every day, we use countless switches in a wide range of environments. Consider a morning routine: turning on the light in a humid bathroom, starting up the coffee maker, turning on/off the outdoor lights on the way to the garage, etc. – all using switches in different places. Not only must the electronic components inside meet demanding specifications, the housings of switches and fuses should also resist varied environmental factors such as moisture, UV radiation and heat/cold. To ensure long service life and proper insulation of the electronics encased therein, it is necessary to monitor the mechanical properties of the materials from which the housings are made.

The housings of electrical components are made from thermoplastics such as PA66 (a.k.a. "Nylon") which have a semi-crystalline structure. The glass transition temperature is 50-60°C where the PA66 changes from the semi-crystalline structure to amorphous. In this amorphous form, thermoplastics are very hygroscopic. Depending on the function or aesthetic trends, the housings are produced in different colors tinted with mineral color pigments. In the data sheets provided by manufacturers, however, the plastic and elastic properties are specified only for the non-colored thermoplastics: any potential influence of mineral coloring pigments on the mechanical properties is not detailed. But this influence can be determined through instrumented indentation.

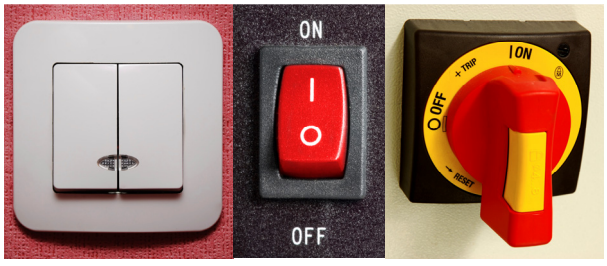

Fig.1: Some of the numerous switches encountered in daily life

The FISCHERSCOPE® HM2000 employs the principle of instrumented indentation and can determine the plastic and elastic properties of thermoplastics. The optional heating stage, SHS200, also makes it possible to take temperature-dependent measurements. As an example, three differently-colored thermoplastics (beige, yellow and red) were analyzed. Besides the color pigments, all other aspects of the composition of the thermoplastic were identical.

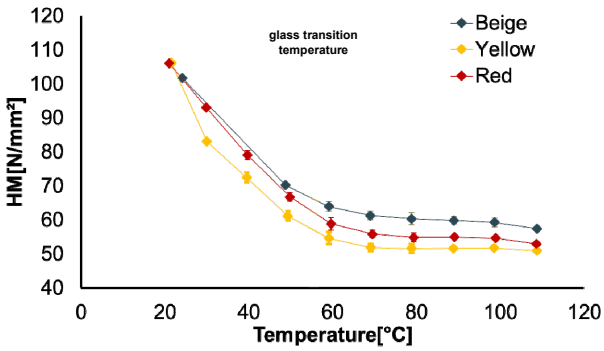

Fig.2: Martens hardness of a thermoplastic in different colour variations as a function of temperature

Figure 2 shows the Martens hardnesses (including standard deviation) of the three samples at different temperatures. While all three colors have nearly identical hardness values at room temperature (~20°C), the situation changes as heat is applied, showing the influence of the color pigments. The Martens hardness of all three samples quickly drops as the sample is warmed up; because the mobility of the molecules in the amorphous parts of the thermoplastic increases at different rates, thus reducing its strength. At higher temperatures the Martens hardness varies only slightly. Measurements were made up to the maximum temperature at which these thermoplastics should be used which is about 120°C.

The FISCHERSCOPE® HM2000 along with the heating stage SHS200 can be used to understand the influence of different color thermoplastics on the mechanical properties at rising temperatures. For further details, please contact your local FISCHER representative.