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Mechanochromic Behavior of a Luminescent Elastomer under Tensile Deformation

Jimin Ha, Yeon Ju Kim, Kwang-Un Jeong, Changwoon Nah
BK21 Plus Haptic Polymer Composite Research Team, Department of Polymer-Nano Science and Technology, Chonbuk National University, Jeonju 561-756, Republic of Korea
kite4748@naver.com; yeoju9209@hanmail.net; kujeong@jbnu.ac.kr; cnah@jbnu.ac.kr

Extended Abstract

Mechanochromic polymers, classified by polymers respond optically to mechanical stimuli, have attracted a great interest and shown a significant progress in recent years. Thermoplastic semi-crystalline polymers, such as thermoplastic polyurethane (TPU), polyethylene (PE) and polymethylmethacrylate (PMMA), containing aggregachromic dye are typical examples which show mechanochromic behavior. Various examples are reported of chromogenic materials composed of a functional dye covalently linked to the polymer chains or physically dispersed in the continuous macromolecular matrix, the latter appears to be a more sustainable route for the industrial scale-up of these materials.

In this study, a mechanochromic elastomer was prepared by physically dispersing dye materials into a rubber matrix by solution mixing technique. The employed rubbers are natural rubber (NR) and silicone rubber (SR). The NR was chosen because of its ability of srain-induced crystallization. The SR was chosen because of its transparency. Perylene derivative is selected after considering its aggregachromic nature and affinity with rubber matrices.

The optimum composition of dye in rubber composites was determined based on the mechanochromic performance characterized with ultraviolet/visible (UV/Vis) spectrometer, x-ray diffraction (XRD) and spectrofluorometer (FL). The UV/Vis spectrometer determines the dye dispersion in polymer film during the tensile deformation. The XRD monitors the change in size of dye aggregates. The FL monitors the optical response during tensile deformation due to the re-arrangement of dyes. The effect of strain-induced crystallization on the mechanochromism was also investigated.

During stretching, dye aggregates were broken because the shear force is applied to dye aggregates. As a result, UV absorbance of dye aggregates was decreased and FL emission intensity of dye aggregates was also decreased.

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