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Abstract

Effect of Accelerated Weathering on the Structural and Thermo-Mechanical Behavior of Polymeric Materials Based on PMMA/PU/Cellulose-g-PMMA †

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Interpenetrating polymer networks (IPNs) of poly(methyl methacrylate) (PMMA)/poly(urethane) PU exhibit good mechanical strength and weather resistance. PMMA/PU IPNs have been studied due to their balanced combination of stiffness, flexibility, and chemical resistance. Grafting crystalline nanocellulose (CNC) onto PMMA to obtain particles that enhance compatibility, improve tensile strength, and impart degradability has not been studied when dispersing it into PMMA/PU IPNs. For this reason, IPNs were obtained through sequential polymerization using 50/50 ($PMMA_{50}/PU_{50}$) and 80/20 ($PMMA_{80}PU_{20}$) ratios and different wt% of CNC_x grafting (x = 5, 10, 20, 30 wt%) onto PMMA to obtain $PMMA_xCNC_y$ particles, which were dispersed during the synthesis in 0.1 and 0.5 wt%. This study presents the results of their characterization through mechanical testing performed before and after accelerated weathering to evaluate the effects of the accelerated weathering (ACW) test in a QUV following ASTM G154 for 672 h. Mechanical, thermo-mechanical, and structural analyses were performed through a tensile test, dynamic mechanical analysis (DMA), and thermogravimetric analysis (TGA) to determine the final properties after ACW. The sample that was reinforced in stress and Young's modulus is when 0.1 wt% $PMMA_{70}CNC_{30}$ particles are added into 50/50 PMMA/PU. The sample closest to the stress of the pure sample was $PMMA_{50}PU_{50}/PMMA_{70}CNC_{30}$ (0.1 wt%), exhibiting minimal damage in stress and strain after ACW. For $PMMA_{80}PU_{20}$ systems, reinforcement was made for the following samples: $PMMA_{80}PU_{20}/PMMA_{95}CNC_5$ (0.1 wt%), $PMMA_{80}PU_{20}/PMMA_{95}CNC_5$ (0.5 wt%), $PMMA_{80}PU_{20}/PMMA_{90}CNC_{10}$ (0.1 wt%), and $PMMA_{80}PU_{20}/PMMA_{70}CNC_{30}$ (0.1 wt%). $PMMA_{80}PU_{20}/PMMA_{70}CNC_{30}$ (0.1 wt%) was the most durable material in the 80/20 sample after ACW. Thermo-mechanical analysis indicates an increase in stiffness, changing the glass transition in dependence on the type of particle added, and the structural analysis indicates minimal damage.

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