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# Effect of Citric Acid on Hydrogen-Bond Interactions and Tensile Retention Properties of Citric Acid Modified Thermoplastic Starch Biocomposites

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**Abstract :** The tensile retention and waterproof properties of thermoplastic starch (TPS) resins were significantly enhanced by modifying with proper amounts of citric acid (CA) and by melt-blending with poly(lactic acid) (PLA), although no distinguished chemical reaction occurred between CA and starch molecules. As evidenced by Fourier transform infrared spectroscopy and Solid-state 13C Nuclear Magnetic Resonance analyses, disruption of intra and interhydrogen-bondings within starch molecules did occur during the modification processes of CA modified TPS (i.e. TPS100CAx) specimens. The tensile strength (σf) retention values of TPS specimens reduced rapidly from 27.8 to 20.5 and 0.4 MPa, respectively, as the conditioning time at 20°C/50% relative humidity (RH) increased from 0 to 7 and 70 days, respectively. While the elongation at break (εf) retention values of TPS specimens increased rapidly from 5.9 to 6.5 and 34.8%, respectively, as the conditioning time increased from 0 to 7 and 70 days. After conditioning at 20°C/50% RH for 70 days, the σf and εf retention values of the best prepared (TPS100CA0.1)30PLA70 specimen are equivalent to 85% and 167% of its initial σf and εf values, respectively, and are more than 105 times higher but 48% lower than those of TPS specimens conditioned at 20°C/50% RH for the same amount of time. Demarcated diffraction peaks, new melting endotherms of recrystallized starch crystals and distinguished ductile characteristics with drawn debris were found for many conditioned TPS specimens, however, only slight retrogradation effect and much less drawn debris was found for most conditioned TPS100CAx and/or (TPS100CA0.1)xPLAy specimens. The significantly improved water proof, tensile retention properties and relatively unchanged in retrogradation effect found for most conditioned TPS100CAx and/or (TPS100CA0.1)xPLAy specimens are apparently due to the efficient blocking of the moisture-absorbing hydroxyl groups (free or hydrogen bonded) by hydrogen-bonding CA with starch molecules during their modification processes.

**Keywords :** thermoplastic starch, hydrogen-bonding, water proof, strength retention
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