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● Effect of lignin functionalization on the modification of polypropylene surface energy and adhesion properties

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Abstract content

Low surface energy and poor adhesion properties are well-known characteristics of polypropylene (PP). Polymer blending can be used as a strategy to alter the wettability of PP and increase the resistance of PP adhesive joints. In this context, lignin, a renewable biopolymer, appears as a promising hydrophilization agent, due to its amphiphilic character [1]. Although encouraging results have been found, the inclusion of lignin in a PP-matrix is not a straightforward task, due to the low compatibility that severely compromises the mechanical properties. To overcome this limitation, different lignin chemical modification procedures have been proposed, but their effect on surface energy modification and adhesion properties of PP are yet unknown. First, Kraft lignin (KL) obtained as a byproduct of paper and pulping industry was oxyproprylated through reaction with propylene oxide. Then, the oxypropylated KL (oxy-KL) was further acetylated by two reagents: acetic anhydride and maleic anhydride (A-oxy-KL and M-oxy-KL, respectively), totaling two conditions of modified KL. All the chemical modification reactions were confirmed by Fourier transformed infrared spectroscopy (FTIR) and differential scanning calorimetry (DSC). Then, PP-composites, as well as pristine PP, were prepared in a twin-screw extruder adding A-oxy-KL and M-oxy-KL to PP in different concentrations. The variation in wettability and surface energy of the substrates was assessed by contact angle measurement. Additionally, the effect of modified lignin on thermal properties and microstructure of the composites was evaluated by DSC. Finally, the practical adhesive strength was evaluated by peel test of PP and PP-composites films bonded to aluminized bioriented polypropylene using a polyurethane adhesive. Results revealed that lignin chemical modification increases the surface energy of PP-composites when compared to pristine PP and PP-KL. DMA and DSC results showed that the glass transition and melting temperature are not significantly affected by lignin inclusion as well as the mechanical properties. Composites with M-oxy-KL showed the best adhesion results, confirming the lignin functionalization is a practical approach to improve the practical adhesion of PP films.

References

[1] R.R. de Sousa Junior, J.R. Gouveia, D.J. dos Santos, Mater. Res. 22 (2019).