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Preparation and Characterization of Poly(L-Lactic Acid)/Oligo(D-Lactic Acid) Grafted Cellulose Composites

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Abstract : With the growth of environmental awareness, enormous researches are running to develop the next generation materials based on sustainability, eco-competence, and green chemistry to preserve and protect the environment. Due to biodegradability and biocompatibility, poly (L-lactic acid) (PLLA) has a great interest in ecological and medical applications. Also, cellulose is one of the most abundant biodegradable, renewable polymers found in nature. It has several advantages such as low cost, high mechanical strength, biodegradability and so on. Recently, an immense deal of attention has been paid for the scientific and technological development of α-cellulose based composite material. PLLA could be used for grafting of cellulose to improve the compatibility prior to the composite preparation. Here it is quite difficult to form a bond between lower hydrophilic molecules like PLLA and α-cellulose. Dimmers and oligomers can easily be grafted onto the surface of the cellulose by ring opening or polycondensation method due to their low molecular weight. In this research, α-cellulose extracted from jute fiber is grafted with oligo(D-lactic acid) (ODLA) via graft polycondensation reaction in presence of para-toluene sulphonic acid and potassium persulphate in toluene at 130°C for 9 hours under 380 mmHg. Here ODLA is synthesized by ring opening polymerization of D-lactides in the presence of stannous octoate (0.03 wt% of lactide) and D-lactic acids at 140°C for 10 hours. Composites of PLLA with ODLA grafted α-cellulose are prepared by solution mixing and film casting method. Confirmation of grafting was carried out through FTIR spectroscopy and SEM analysis. A strongest carbonyl peak of FTIR spectroscopy at 1728 cm^{-1} of ODLA grafted α-cellulose confirms the grafting of ODLA onto α-cellulose which is absent in α-cellulose. It is also observed from SEM photographs that there are some white areas (spot) on ODLA grafted α-cellulose as compared to α-cellulose may indicate the grafting of ODLA and consistent with FTIR results. Analysis of the composites is carried out by FTIR, SEM, WAXD and thermal gravimetric analyzer. Most of the FTIR characteristic absorption peak of the composites shifted to higher wave number with increasing peak area may provide a confirmation that PLLA and grafted cellulose have better compatibility in composites via intermolecular hydrogen bonding and this supports previously published results. Grafted α-cellulose distributions in composites are uniform which is observed by SEM analysis. WAXD studied show that only homo-crystalline structures of PLLA present in the composites. Thermal stability of the composites is enhanced with increasing the percentages of ODLA grafted α-cellulose in composites. As a consequence, the resultant composites have a resistance toward the thermal degradation. The effects of length of the grafted chain and biodegradability of the composites will be studied in further research.

Keywords : α-cellulose, composite, graft polycondensation, oligo(D-lactic acid), poly(L-lactic acid)
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