

PREPARATION AND CHARACTERIZATION OF RICE STARCH AND
TRANSITION METAL STEARATES FILLED POLYPROPYLENE

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ABSTRAK

Fleksibiliti tinggi plastik sintetik dari segi sifat mekanikal dan ketahanan telah menjadi faktor kemerosotan persekitaran semula jadi. Kajian ini telah dijalankan ke arah pembangunan dan penggunaan plastik degradasi sebagai alternatif untuk menggantikan plastik komoditi. Kanji beras yang tidak dirawat (URS), kanji beras dirawat (TRS) dan stearat logam peralihan (TMS) digunakan sebagai pengisi dan digabungkan dengan polipropilena (PP). URS, TRS dan TMS diisi PP telah disediakan melalui teknik ekstrusi dan penyuntikan acuan. URS dan TRS dicampur dengan PP dengan kepekatan masing-masing 10, 20, 30, 40 dan 50 wt %. Komposisi TMS (CoSt_3 dan FeSt_3) sebanyak 0.1, 0.3, 0.5, 0.7 dan 0.9 phr digabung dengan PP. Campuran yang disediakan dianalisis dari segi sifat mekanikal seperti kekuatan tegangan (TS), modulus tegangan (TM) dan peratus pemanjangan pada takat putus (EB). Ciri-ciri termo-oksidatif telah dikaji dengan menggunakan analisis termogravimetrik (TGA) dan kalori simetri pengimbasan (DSC). Kadar degradasi telah dikaji dengan menggunakan degradasi enzimatik dan ujian kaji cuaca yang dipercepatkan. Ciri-ciri degradasi dan morfologi permukaan diperhatikan menggunakan spektroskopi inframerah transformasi fourier (FTIR) dan analisis mikroskop elektron (SEM). Keputusan menunjukkan TS dan TM sampel yang mengandungi URS dan TRS berkurangan dengan peningkatan kandungan URS dan TRS. Keputusan menunjukkan TS dan TM maksimum kedua-dua CoSt_3 dan FeSt_3 pada kepekatan TMS sebanyak 0.5 phr. Analisis DSC menunjukkan bahawa entalpi dan peratus penkristalan sampel yang mengandungi URS dan TRS menurun, manakala peratus penkristalan sampel PPFe_5 lebih tinggi berbanding sampel PPFe_5 . Tambahan pula, T_{max} yang lebih tinggi dalam sampel TRS diisi dengan PP berbanding dengan sampel URS diisi dengan PP membuktikan TRS meningkatkan kestabilan terma sampel. Keputusan TGA menunjukkan bahawa PPCo_5 mempunyai T_{max} yang lebih tinggi berbanding dengan PPFe_5 . CoSt_3 yang mempamerkan suhu penguraian yang lebih tinggi berbanding FeSt_3 . Melalui degradasi enzimatik, sampel yang mengandungi URS dan TRS mengalami pengurangan berat badan tertinggi selepas 10, 20 dan 30 hari untuk 50 wt % berat URS dan TRS. Pengurangan berat dalam kedua-dua sampel PPCo_5 dan PPFe_5 sangat sedikit selepas degradasi enzim. Perubahan warna yang ketara dapat diperhatikan dalam sampel yang mengandungi URS dan TRS selepas ujian kajicucua yang dipercepatkan. Ujian sama menunjukkan bahawa keupayaan CoSt_3 sebagai pro-oksidan yang lebih baik daripada FeSt_3 seperti yang dilihat dalam penampilan visual dan analisis SEM. Penggabungan URS, TRS dan TMS ke dalam matriks PP mempamerkan beberapa perubahan ketara ke atas sifat campuran plastik yang dihasilkan. Dalam semua campuran, penurunan sifat mekanikal dan terma telah diperhatikan tetapi peningkatan yang ketara dalam kadar degradasi sampel boleh diperhatikan. Penggantian matriks PP dengan pengisi dapat meningkatkan kecenderungannya ke arah degradasi. Dari analisis data, TMS bertindak sebagai pengisi terbaik di antara ketiga-tiga pengisi yang telah diadun dengan PP diikuti oleh TRS dan URS. Secara ringkasnya, campuran pengisi semula jadi dan pro-oksidan yang berasaskan plastik sintetik boleh menjadi penyelesaian yang baik untuk menyelesaikan isu-isu alam sekitar yang disebabkan oleh sisa plastik yang tidak terbiodegradasi.

ABSTRACT

The high versatility of synthetic plastics in terms of mechanical properties and durability has become a deteriorating factor of natural environment. In response to these issues, this study has been directed towards development and application of degradable plastics as an alternative to replace commodity non degradable plastics. Untreated rice starch (URS), treated rice starch (TRS) and transition metal stearates (TMS) were used as fillers and incorporated with polypropylene (PP). URS, TRS and TMS filled PP samples were prepared through extrusion and injection molding technique. URS and TRS were mixed with PP with a concentration of 10, 20, 30, 40 and 50 wt % respectively. Composition of TMS (CoSt_3 and FeSt_3) of 0.1, 0.3, 0.5, 0.7 and 0.9 phr was blended with PP. The prepared blends were characterized by tensile properties such as tensile strength (TS), tensile modulus (TM) and percentage of elongation at break (EB). The thermo-oxidative properties were studied by using thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). Degradability of blends was studied by using enzymatic degradation and accelerated weathering test. The degradation properties and surface morphologies were observed using fourier transform infrared spectroscopy (FTIR) and scanning electron microscope (SEM) analysis. The results indicated that TS and TM of URS and TRS filled PP samples reduced as the composition of starch increases. The results indicated that maximum TS and TM of both CoSt_3 and FeSt_3 at concentration of TMS of 0.5 phr. DSC analysis showed that enthalpy and crystallinity of URS and TRS filled PP samples dropped as the composition of URS and TRS increased from 10- 50 wt % meanwhile crystallinity of PPF5 samples were much higher than PPCo5 samples. Furthermore, higher T_{max} in PP/TRS compared to PP/URS signified that the incorporation of TRS improved the thermal stability of the blends with the increase in the composition of starch (10-50 wt %). TGA results showed that PPCo5 has a higher T_{max} as compared to PPF5 and CoSt_3 exhibits higher decomposition temperature as compared to FeSt_3 . During enzymatic degradation, URS and TRS filled PP samples experienced highest weight reduction after the 10, 20 and 30 days for 50 wt % URS and TRS. The weight loss in both PPCo5 and PPF5 samples are almost negligible after enzymatic degradation. Significant discoloration was observed in both URS and TRS filled PP samples after accelerated weathering test. Same test showed that the ability of CoSt_3 as pro-oxidant is more deteriorating than FeSt_3 as observed in visual observation and SEM analysis of samples. The incorporation of URS, TRS and TMS into PP matrices exhibits some significant changes on the properties of plastic blends been produced. In all the formulation, it was observed decrease in mechanical and thermal properties but a significant improvement in the degradability of samples can be observed. Substitution of PP matrix with fillers can improve its susceptibility towards degradation. From the data analysis, TMS acts as best filler among all the three fillers been blended with PP followed by TRS and URS. Conclusively, filling of natural filler and pro-oxidants into synthetic plastics can be a great solution to solve the environmental issues caused by non-degradable plastic wastes.