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Supporting Information.

Super Impact Absorbing Bio-alloys from Inedible Plants by a Green Process

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Experimental

1. Materials

PP (NOVATEC MA1B) and PA11 (RILSAN BMN O) used in this study were purchased from the Japan Polypropylene Corp. and Arkema, respectively. The reactive compatibilizer was m-EBR (TAFMER MH7020), purchased from Mitsui Chemicals. PP/PA11 bio-alloys with different ratios of PP and PA11, and with a constant amount of reactive compatibilizer were prepared as listed in Table 1. To promote the reaction between the terminal amino groups of PA11 and the maleic anhydride groups of m-EBR, PA11 and m-EBR were premixed in a twin-screw extruder (Technovel Co. KZW15-60MG) at 210 °C and at 200 rpm. The obtained premixture was then

mixed with PP under the same conditions. This study employed an extrusion rate of approximately 2 kg/h. The sample numbers and the associated proportions of PP/PA11/compatibilizer are shown in Table 1. Test pieces (80×10×4 mm^3) were prepared by injection molding (Nissei Plastic Industrial Co., Ltd. PS40E2ASE) to allow measurement of the mechanical properties according to the ISO 20753. A one-step procedure was also conducted using a production model twin-screw extruder (The Japan Steel Works, LTD. TEX30 α 77BW-20V) at 200 °C and at 500 rpm, where an extrusion rate of approximately 5 kg/h was employed. Test pieces (multi-purpose testing) were prepared by injection molding (Nissei Plastic Industrial Co., Ltd. NEX1000-9E) to allow measurement of the mechanical properties according to the ISO 20753.

2. Mechanical Property Measurements.

The flexural modulus of each injection molded test specimen was measured using a Shimadzu Autograph AG-10kND. Tests were repeated five times at a rate of 2 mm/min. The Charpy notched impact test was repeated ten times at room temperature using an impact test machine. The hammer for the impact test was changed from 0.5 to 15 J, depending on the impact strength of the sample. The samples for mechanical tests were conditioned at 23±2 °C and at 50±10% relative humidity for 48 h before testing.

3. Morphology Observations.

Freeze-fracture surfaces of specimens coated with osmium were observed using field emission-scanning electron microscopy (FE-SEM) (Hitachi S-4300) with an operating voltage of 2 kV. To obtain additional information, some freeze-fracture surfaces were subjected to oxygen plasma treatment for 60 s. The treated freeze-fracture surfaces were also evaluated using FE-SEM under the same conditions. Raman spectra were recorded on a Renishaw inVia Raman microscope equipped with a charge-coupled device (CCD) detector and 532 nm laser excitation. Raman imaging of bio-alloys on an aluminum mirror was conducted by scanning each sample using an XYZ motorized stage over an area of 10×10×10 μm. The laser scan step along the X and Y directions was 1 μm and 2.4 μm along the Z direction, and the exposure time was set at 3 s per step. Both the Raman spectra and images were generated using the WiRE 3.0 software package (Renishaw). The direct classical least squares method (DCLS) was used to generate chemical component maps.

Some samples were also examined in detail using transmission electron microscopy (Jeol JEM1230) with an operating voltage of 120 kV. The specimens were prepared using an ultramicrotome after RuO_4 and OsO_4 staining and were coated with platinum.[1]

References

1 H. Sano, T. Usami and H. Nakagawa, *Polymer*, 1986, **27**, 1497–1504.