

MORPHOLOGICAL CHARACTERIZATION AND MECHANICAL PROPERTIES OF POLY(LACTIC ACID)/EPOXIDIZED NATURAL RUBBER FOAM

INTISARI

Oleh:

OSVALDO MANUEL GOSAL

15/385588/TP/11457

Busa poli asam laktat (PLA) dianggap sebagai salah satu alternatif yang menjanjikan untuk mensubstitusi busa konvensional berbasis minyak bumi, khususnya busa polistiren (PS). Namun, PLA memiliki beberapa kelemahan terkait dengan pemrosesan dan penggunaannya, seperti kerapuhan, kekuatan leleh rendah, dan kemampuan pembusaan yang buruk. Oleh karena itu, penambahan karet alam terepoksidasi (ENR) dipertimbangkan. Penelitian ini mempelajari pengaruh penambahan ENR ke PLA, menggunakan azodikarbon amida sebagai zat peniup, pada kepadatan, morfologi, dan sifat mekanis dari busa campuran PLA/ENR. Pembuatan busa PLA/ENR dilakukan dengan pencetakan kompresi. Dua jenis ENR yang digunakan adalah ENR dengan 25 mol% dan 50 mol% kelompok epoksi, dinamakan ENR-25 dan ENR-50, masing-masing. Pada bagian pertama penelitian, rasio PLA/ENR untuk ENR-25 dan ENR-50 adalah 40:60, 50:50, dan 60:40, dengan penambahan zat peniup 5 phr. Kepadatan busa terendah (0.27 g/cm^3) dan ukuran sel terkecil ($110.4 \mu\text{m}$) diperoleh untuk PLA/ENR-50 dengan rasio 60:40. Sifat mekanis dari busa PLA/ENR meningkat secara signifikan dengan penambahan ENR-50, dibandingkan dengan ENR-25. Busa PLA/ENR-50 pada rasio 60:40 menunjukkan kekuatan tarik dan tekan tertinggi masing-masing 1.22 MPa dan 6.45 MPa. Perpanjangan putus tertinggi (425%) diperoleh PLA/ENR-50 dengan rasio 40:60. Pada bagian kedua penelitian, rasio PLA/ENR-50 yang dipilih adalah 60:40 dengan berbagai konsentrasi zat peniup pada 3, 5, dan 7 phr. Busa dengan struktur sel tertutup diperoleh dengan zat peniup 3 phr, sedangkan struktur sel terbuka diperoleh dengan 7 phr. Selain itu, ukuran sel terkecil ($66.5 \mu\text{m}$) diperoleh pada 3 phr. Kepadatan busa terendah PLA/ENR-50 didapatkan dengan menambahkan 5 phr zat peniup (0.27 g/cm^3). Terakhir, kekuatan tarik busa tertinggi PLA/ENR-50 dengan 7 phr ditemukan pada 1.24 MPa, sedangkan perpanjangan putus (105%) dan kekuatan tekan tertinggi (7.18 MPa) diperoleh busa PLA/ENR-50 dengan konsentrasi zat peniup 3 phr.

Kata kunci: *Poli Asam Laktat, Karet Alam Terepoksidasi, Azodikarbon amida, Morfologi, Sifat Mekanis, Kepadatan Busa*

MORPHOLOGICAL CHARACTERIZATION AND MECHANICAL PROPERTIES OF POLY(LACTIC ACID)/EPOXIDIZED NATURAL RUBBER FOAM

ABSTRACT

By:

OSVALDO MANUEL GOSAL

15/385588/TP/11457

Poly(lactic acid) (PLA) foam is considered as one of the promising alternatives to the conventional petroleum-based foam, more specifically polystyrene (PS) foam. However, PLA has several drawbacks regarding to its processing and usage, such as brittleness, low melting strength, and poor foamability. Therefore, to overcome these problems, the addition of epoxidized natural rubber (ENR) was considered. This research studied the effect of adding ENR to PLA, using azodicarbonamide as a chemical blowing agent, on the density, morphology, and mechanical properties of PLA/ENR blend foam. Compression-molding was performed in order to fabricate the PLA/ENR foam. Two types of ENR used were ENR with 25 mol% and 50 mol% epoxy groups, named as ENR-25 and ENR-50, respectively. In the first part of the experiment, the ratios of PLA/ENR for both ENR-25 and ENR-50 were 40:60, 50:50, and 60:40, with the addition of blowing agent 5 phr. The lowest foam density (0.27 g/cm^3) and smallest cell size ($110.4 \mu\text{m}$) was obtained for PLA/ENR-50 with the ratio of 60:40. The mechanical properties of PLA/ENR foam improved significantly by adding ENR-50, compared with that of ENR-25. PLA/ENR-50 foam at a ratio of 60:40 showed the highest tensile and compressive strength of 1.22 MPa and 6.45 MPa, respectively. The highest elongation at break (425%) was obtained for PLA/ENR-50 at a ratio of 40:60. In the second part of the experiment, the selected ratio of PLA/ENR-50 was 60:40 with various concentrations of the blowing agent at 3, 5, and 7 phr. A closed-cell structure of the foam was obtained with 3 phr blowing agent, while an open-cell structure was obtained with 7 phr. Besides, the smallest cell size ($66.5 \mu\text{m}$) was obtained at 3 phr. The lowest foam density of PLA/ENR-50 was found by adding 5 phr of blowing agent (0.27 g/cm^3). Lastly, the tensile strength of PLA/ENR-50 foam consisting 7 phr was found to be the highest at 1.24 MPa, while the highest elongation at break (105%) and compressive strength (7.18 MPa) were obtained by PLA/ENR-50 foam with the level of 3 phr blowing agent.

Keywords: *Polylactic acid, Epoxidized Natural Rubber, Azodicarbonamide, Morphology Characterization, Mechanical Property, Foam density*