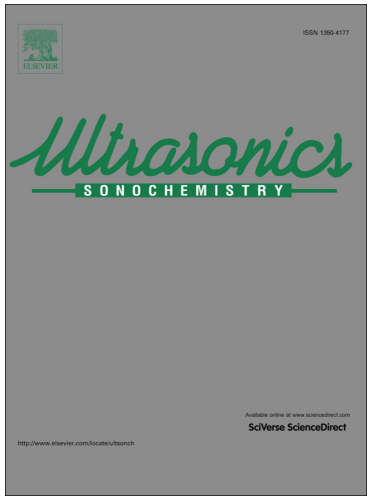

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Processing of ultra-high molecular weight polyethylene/graphite composites by ultrasonic injection moulding: Taguchi optimization

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Abstract

Ultrasonic injection moulding was confirmed as an efficient processing technique for manufacturing ultra-high molecular weight polyethylene (UHMWPE)/graphite composites. Graphite contents of 1 wt%, 5 wt%, and 7 wt% were mechanically pre-mixed with UHMWPE powder, and each mixture was pressed at 135°C. A precise quantity of the pre-composites mixtures cut into irregularly shaped small pieces were subjected to ultrasonic injection moulding to fabricate small tensile specimens. The Taguchi method was applied to achieve the optimal level of ultrasonic moulding parameters and to maximize the tensile strength of the composites; the results showed that mould temperature was the most significant parameter, followed by the graphite content and the plunger profile. The observed improvement in tensile strength in the specimen with 1 wt% graphite was of 8.8% and all composites showed an increase in the tensile modulus. Even though the presence of graphite produced a decrease in the crystallinity of all the samples, their thermal stability was considerably higher than that of pure UHMWPE. X-ray diffraction and scanning electron microscopy confirmed the exfoliation and dispersion of the graphite as a function of the ultrasonic processing. Fourier transform infrared spectra showed that the addition of graphite did not influence the molecular structure of the polymer matrix. Further, the ultrasonic energy led oxidative degradation and chain scission in the polymer.

Keywords: UHMWPE/graphite composites, ultrasonic injection moulding, polymer chain scission.

1. Introduction.

Ultra-high molecular weight polyethylene (UHMWPE) is a useful thermoplastic possessing remarkable physico-mechanical properties: such as high impact strength, good chemical stability, low coefficient of friction, good abrasion resistance, electrical insulation, and self-lubrication [1]. Therefore, UHMWPE is in high demand for application in various fields such as the mining industry (e.g. guiding rails and covering for bunkers); mechanical engineering (e.g. construction materials subjected to shock loading and abrasion); textile