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Graphene Reinforced Magnesium Metal Matrix Composites for Biomedical Applications

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Abstract : Magnesium (Mg) metal matrix composites (MMCs) reinforced with graphene nanoplatelets (GNPs) have been developed by powder metallurgy (PM). In this study, GNPs with different concentrations (0.1-0.3 wt.%) were dispersed into Mg powders by high-energy ball-milling processes. The microstructure and resultant mechanical properties of the fabricated nanocomposites were characterized using transmission electron microscopy (TEM), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDX), X-ray diffraction (XRD), Raman spectroscopy (RS), compression and nano-wear tests. The corrosion resistance of the fabricated composites was evaluated by electrochemical tests and hydrogen evolution measurements. Finally, the biological response of Mg-GNPs composites was assessed using osteoblast-like SaOS2 cells. The results indicate that GNPs are excellent candidates as reinforcements in Mg matrices for the manufacture of biodegradable Mg-based composite implants. GNP addition improved the mechanical properties of Mg via synergetic strengthening modes. Moreover, retaining the structural integrity of GNPs during PM processing improved the ductility, compressive strength, and corrosion resistance of the Mg-GNP composites as compared to monolithic Mg. Cytotoxicity assessments did not reveal any significant toxicity with the addition of GNPs to Mg matrices. This study demonstrates that Mg-xGNPs with $x < 0.3$ wt.%, may constitute novel biodegradable implant materials for load-bearing applications.

Keywords : magnesium-graphene composites, strengthening mechanisms, In vitro cytotoxicity, biocorrosion
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