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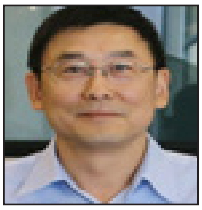
Development of graphene-reinforced magnesium metal matrix composites for biodegradable bone implants



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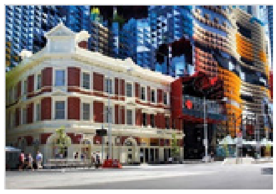
Biography

Yuncang Li obtained his PhD in Materials Science Engineering from Deakin University in 2004 and then took up a research position in Biomaterials Engineering at Deakin University until the end of 2014. He joined RMIT University in 2015. He was awarded an Australian Research Council (ARC) Future Fellowship and won a number of national competitive grants including ARC and Australian National Health and Medical Research Council projects. His research focuses on developing metallic biomaterials for medical applications. He has expertise in microstructure-mechanical property relationships, corrosion, and biocompatibility, surface modification, nanostructured metals and alloys, and metal foams. His research has led to over 200 peer-reviewed original publications, with an H index of 36 and over 3640 citations (Google Scholar).



Abstract

Despite the promising prospects of magnesium (Mg) alloys over conventional metallic biomaterials, there are still several challenges for bone implants such as the insufficient mechanical strength and ductility of Mg alloys and its rapid degradation in the physiological environment before adequate bone healing. Nano-sized reinforcements have the potential to enhance the mechanical properties of metal matrices by Orowan strengthening and load-transfer strengthening mechanisms. In this study, powder metallurgy (PM) fabrication routes was used to fabricated new magnesium (Mg) metal matrix composites (MMCs) reinforced with graphene nanoplatelets (GNPs) for biomedical applications. GNPs (0.1, 0.2, 0.3 wt.%) with variable layer thicknesses and sizes were dispersed into Mg powder using high-energy ball-milling (BM) processes. The microstructure of the fabricated composites was characterized using transmission electron microscopy (TEM), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDX), optical microscopy (OM), X-ray diffraction (XRD), and Raman spectroscopy (RS). The mechanical properties were evaluated by compression tests. The corrosion resistance was investigated by electrochemical tests and hydrogen evolution measurements. The cytotoxicity was assessed using osteoblast-like cells. The results indicate that GNPs are excellent candidates as reinforcements in Mg matrices for the manufacture of biodegradable Mg implants. GNP addition improved the mechanical properties of Mg via synergetic strengthening modes including grain-refinement strengthening, thermal-mismatch strengthening, dispersion strengthening, and load-transfer strengthening. Moreover, retaining the structural integrity of dispersed GNPs improved the ductility, compressive strength, and corrosion resistance of the Mg–GNP composites. Cytotoxicity assessments did not reveal any significant adverse effects on biocompatibility with the addition of GNPs to Mg matrices. Mg–xGNPs with $x < 0.3$ wt.% may constitute promising biodegradable implant materials for load-bearing applications.

Publications

Yunfei Ding, Cuie Wen, Peter Hodgsona and Yuncang Li, Effects of alloying elements on the corrosion behavior and biocompatibility of biodegradable magnesium alloys: a review (2014), Journals of Materials Chemistry

Jun Liu, Chunping Liu, Yanling Wan, Yuncang Li et. Al, Facile synthesis of NiCo2O4 nanorod arrays on Cu conductive substrates as superior anode materials for high-rate Li-ion batteries (2013), CrystEngComm

MonaAlizadeh-Osgouei, YuncangLi and CuieWen, A comprehensive review of biodegradable synthetic polymer-ceramic composites and their manufacture for biomedical applications (2019), Journal of Bioactive Materials

Arne Biesiekierski, Dehai Ping, Yuncang Li, Jixing Lin, Khurram S.Munir, Yoko Yamabe-Mitarai, Cuie Wen, Extraordinary high strength Ti-Zr-Ta alloys through nanoscaled, dual-cubic spinodal reinforcement, Journal of Acta Biomaterialia

Khurram S munir, Li Yuncang, Lin Jixing, Wen Cuiea, Interdependencies between graphitization of carbon nanotubes and strengthening mechanisms in titanium matrix composites, Journal of Materialia

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