Insight of magnesium matrix nanocomposites for biomedical applications - a synthetic review

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Traditional biomaterials, such as Ti alloys, Co-based alloys and stainless steel, often show unsatisfactory results such as metal ion release and stress shielding in biomedical applications [1]. Orthopedic implants are divided into permanent and temporary implants. After healing the body part and to avoid long-term exposure of the toxic implant contents to the body, secondary surgical operation(s) are normally needed to remove the implants [2]. As a result, bio-dissolvable implants are an absolute necessity for resolving these issues. The synthesis of biodegradable materials, such as metals, alloys, and nanocomposites, is revolutionizing metallic biomaterials.

In this article, we had done detailed analysis on the important aspects of Mg matrix nanocomposites (MMNCs) and the effects of nano reinforcements on the biocompatibility, mechanical properties and degradation behavior of MMNCs as future biodegradable implant materials. MMNCs exhibit compatible mechanical and physical properties to human bone in comparison to the traditional used biomaterials. Mg alloys have the Young's modulus (40–45 GPa) nearly to cortical bone (10–27 GPa), whereas the Young's modulus of Ti-based and 316L stainless steel are 110 and 193 GPa, respectively. Mg has the density of 1.74 g/cm^3 similar to density of cortical bone (2.0 g/cm^3), whereas densities of Ti and stainless steel are 4.5 and 8 g/cm^3, respectively [3]. Also, Magnesium implants can decay during healing as Mg is an essential mineral in human body.

The findings of this work lead to the conclusion, that the properties and behavior of Mg-based biomaterials are influenced by the synthesis methods used and the components chosen. MMNCs can replace present commercially used biomaterials as having better compatibility to bone and eliminating further surgical operation(s) for implant removal, if its fundamental problem of undesirably fast degradation within living system can be solved.

Keywords: Magnesium matrix nanocomposites, biomaterials, biomedical applications, orthopedic implants, biodegradable

References

[1] Gupta, Manoj, and Sharon Nai Mui Ling. *Magnesium, magnesium alloys, and magnesium composites*. John Wiley & Sons, 2011.
[2] Moravej, M., & Mantovani, D. (2011). Biodegradable metals for cardiovascular stent application: interests and new opportunities. *International Journal of Molecular Sciences*, *12*(7), 4250-4270.
[3] Purnama, A., Hermawan, H., Couet, J., & Mantovani, D. (2010). Assessing the biocompatibility of degradable metallic materials: state-of-the-art and focus on the potential of genetic regulation. *Acta Biomaterialia*, *6*(5), 1800-1807.