Study on Corrosion of Iron-Zinc Oxide Particulate Composites Produced by a Spark Plasma Sintering in Hanks' Solution

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In an attempt to find an iron-based biomaterial which corrodes more rapidly than a pure iron, an iron-zinc oxide particulate composite was produced by spark plasma sintering a mixture of carbonyl iron micropowder and zinc oxide nanopowder. Composite materials with a ZnO content of 0.5, 1.0 and 5.0 wt.% were manufactured in this way and subsequently tested for corrosion in Hanks' solution. The composites were expected to undergo a galvanic corrosion, with Fe acting as the anode and semiconducting ZnO acting as the cathode. Due to a galvanic stimulation, a composite with the lowest content of ZnO actually corroded twice as fast as did a pure iron produced by a spark plasma sintering. However, in the case of galvanic corrosion and for compositions under investigation, the corrosion potential and corrosion rate of a composite could increase with increasing cathode-to-anode area ratio, that is, with increasing content of ZnO. As the content of ZnO was increased, the corrosion potential indeed increased, but the corrosion current per unit area of composite surface decreased. This decrease in corrosion rate was regarded as being a consequence of a poor electric conductance of ZnO regions, which has led to relevant ohmic potential drops (IR drops) along the galvanic current paths through these regions. Some of possibilities to minimize IR drops and thus to maximize the corrosion rate are mentioned.

Keywords: iron based biomaterial, zinc oxide nanopowder, metal matrix composite, spark plasma sintering, corrosion in Hanks' solution

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