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D. Vijay Kumar, M.J.N.V. Prasad

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Pulsed electrodeposition and hardness of microstructurally graded iron

D. Vijay Kumar*, M.J.N.V. Prasad

Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology Bombay, Powai, Mumbai-400 076, INDIA.

*Corresponding author. *E-mail address:* vijay_kumar@iitb.ac.in

ABSTRACT

Functionally graded materials (FGM) are designed to acquire a desired spectrum of properties within a material with a gradual variation in either microstructure, composition or porosity across the thickness. Microstructurally graded iron with grain sizes from nanocrystalline/sub-microcrystalline to microcrystalline range can facilitate novel applications which demand an optimum combination of strength and toughness with good corrosion resistance. The present study was aimed at providing methods to synthesize and engineer microstructurally graded iron with ultra-fine and coarse grained structure using pulsed electrodeposition. The effect of various parameters like $CaCl_2$ and saccharin contents in the chloride electrolytic bath, pH of the bath and applied current density on developing the microstructurally graded iron deposits was studied. The $CaCl_2$ concentration in the bath has a profound effect on development of microstructure and crystallographic texture. With increasing current density, pH of the bath and saccharin content, there was significant refinement of the grain structure. The microstructurally graded iron deposit produced under optimized electrodeposition conditions exhibited a gradual variation in hardness ranging from ~3 GPa to 10 GPa.

Keywords: Electrodeposition; Iron; Microstructure; Texture; Hardness.