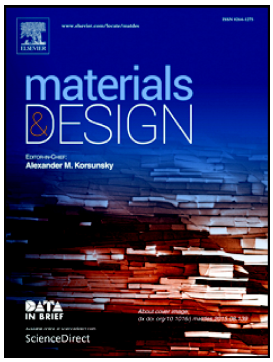
Accepted Manuscript



Mapping of magnetic and mechanical properties of Fe-W alloys electrodeposited from Fe(III)-based glycolate-citrate bath

A. Nicolenco, N. Tsyntsaru, J. Fornell, E. Pellicer, J. Reklaitis, D. Baltrunas, H. Cesiulis, J. Sort

PII: S0264-1275(17)31039-0
DOI: doi:10.1016/j.matdes.2017.11.011
Reference: JMADE 3487

To appear in: *Materials & Design*

Received date: 18 August 2017
Revised date: 3 November 2017
Accepted date: 4 November 2017

Please cite this article as: A. Nicolenco, N. Tsyntsaru, J. Fornell, E. Pellicer, J. Reklaitis, D. Baltrunas, H. Cesiulis, J. Sort , Mapping of magnetic and mechanical properties of Fe-W alloys electrodeposited from Fe(III)-based glycolate-citrate bath. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Jmade(2017), doi:10.1016/j.matdes.2017.11.011

Mapping of magnetic and mechanical properties of Fe-W alloys electrodeposited from Fe(III)-based glycolate-citrate bath

A. Nicolenco[1], N. Tsyntsaru[1, 2,*], J. Fornell[3], E. Pellicer[3], J. Reklaitis[4], D. Baltrunas[4], H. Cesiulis[1,*], J. Sort[3, 5]

[1]*Vilnius University, Physical Chemistry Department, Naugarduko str. 24, Vilnius LT-03225, Lithuania*

[2]*Institute of Applied Physics of ASM, Academiei str. 5, Chisinau, MD-2028, Moldova*

[3]*Departament de Física, Facultat de Ciències, Universitat Autònoma de Barcelona, Bellaterra E-08193, Spain*

[4]*Center for Physical Sciences and Technology, Savanorių av. 231, Vilnius LT-02300, Lithuania*

[5]*Institució Catalana de Recerca i Estudis Avançats (ICREA), Pg. Lluís Companys 23, Barcelona E-08010, Spain*

[*]*E-mail: henrikas.cesiulis@chf.vu.lt*

[*]*E-mail: ashra_nt@yahoo.com*

Abstract

Electrodeposition of Fe-W coatings has been carried out from an environmentally friendly Fe(III)-based glycolate-citrate bath. Samples with tungsten content from 6 to 25 at.% were electrodeposited in a controlled way by changing electrodeposition parameters: current density, pH, and temperature. X-ray diffraction analysis showed that the structure of Fe-W coatings transforms from nanocrystalline to amorphous-like as the W content increases and the crystallite size reduces below 10 nm. However, the peculiarities of the structural transitions are linked not only with the W content. Deposition temperature plays a crucial role, due to the different activation energy of crystallization. Following the direct Hall–Petch relation, a maximum hardness of ~10 GPa was found for the alloy with the highest W content, making it comparable to that of electrolytic chromium. The Fe_2W intermetallic compound forms at higher W concentration as proven by Mössbauer spectroscopy, and contributes to the increased hardness of these alloys. The alloys retain a soft magnetic character within a wide compositional range, although increasing the W content leads to a reduction of the saturation magnetization. Fe-12 at.% W coatings show an optimum combination of mechanical and magnetic properties, thus making these newly developed coatings appealing environmentally-friendly alternative materials for multi-scale technologies.

Keywords: tungsten alloys, iron alloys, electrodeposition, Mössbauer spectroscopy, mechanical properties, magnetic properties.