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Scaling Analysis of the Kinetic Roughening During the Electrodeposition of 2.4T CoFe Alloys

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The electrodeposition of thin films for most of the practical applications occurs at the potentials far from equilibrium resulting in kinetic roughening of the surface during the growth. The evolution of the surface morphology in statistical sense is usually described by following the surface width, *w,* (eq 1.) over the time and space ordinate.

$$w = \sqrt{\left\langle \left(h - \langle h \rangle\right)^2 \right\rangle} \qquad (1)$$

Although the kinetic roughening during the electrodeposition is a complex phenomenon involving many different processes, most of the electrodeposition systems are well described by normal scaling law[1], (eq. 2). However, recently it has been shown[2] that in some systems the anomalous scaling has to be used in order to describe the kinetic roughening of the particular films (eq. 3). The common formulations of the scaling laws are presented below;

$$w(l,t) = l^{\alpha} f(t / l^{\alpha/\beta}) \qquad (2)$$

$$w(l,t) = l^{\alpha} t^{\beta_{loc}} f(t / l^{\alpha/\beta}) \qquad (3)$$

where scaling function f is such that $w(l,t)=l^{\alpha}$ for $(t/l^{\alpha/\beta}) >> 1$ and $w(l,t) = l^{\beta}$ for $(t/l^{\alpha/\beta}) << 1$ and α, β, and β_{loc} are the scaling exponents.

In this talk we will present the results for the scaling analysis of the kinetic roughening of electrodeposited 2.4 T CoFe thin films from the solution containing commonly used additives. The analysis was done on the samples, which were deposited from the same bath chemistry using pulse and direct current deposition method (PC and DC). The AFM[3] roughness measurements were done in the areas where no current crowding was present and where current crowding is expected to have strong influence on the appearance of the growth instabilities. The effect is than quantified through the difference in the measured scaling exponents. For both cases, the roughness evolution was found to follow anomalous scaling law independent on the deposition method (Figure 1 and Figure 2). The scaling exponents extracted from the measurements are discussed in the sense of different relaxation mechanisms playing roles in each deposition method and through the different actions of additives reflected on the evolution of the thin film surface morphology.

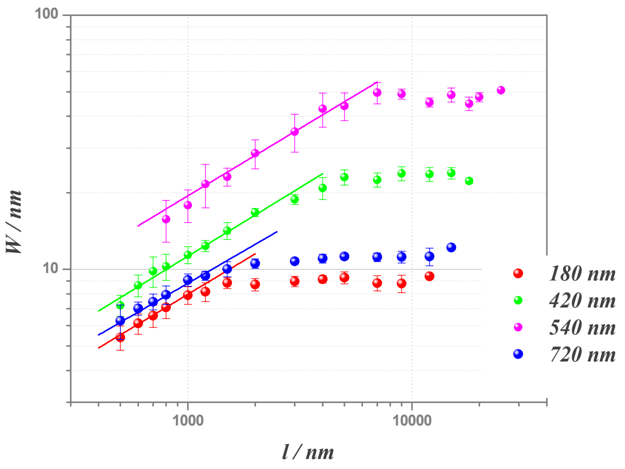

Figure 1. The AFM roughness data for DC electrodeposited CoFe thin films as a function of deposition time (thickness) and length scale.

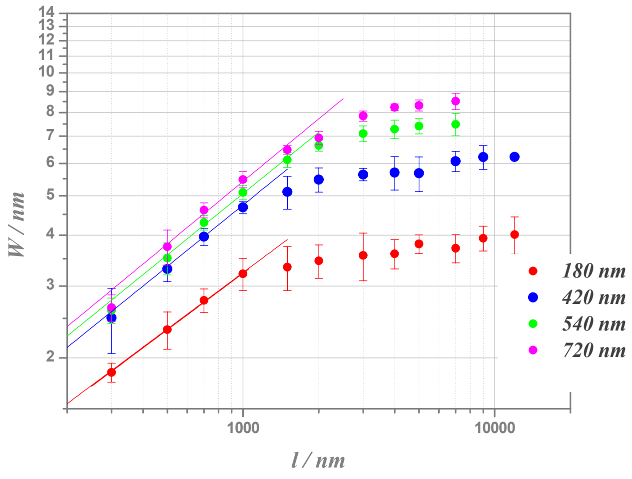

Figure 2. The AFM roughness data for PC electrodeposited CoFe thin films as a function of deposition time (thickness) and length scale.

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[1] F. Family and T. Vicsek, *J. Phys.* A **18**, L75 (1985).
[2] S. Huo and W. Schwarzacher, *Phys. Rev. Lett.* **86**, 256 (2001).
[3] Atomic Force Microscope.