STRUCTURE AND SURFACE MORPHOLOGY OF ANNEALED AND IRRADIATED FePd THIN ALLOY FILMS

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Motivation

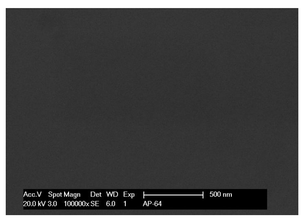
FePd $L1_0$ ordered alloys are highly expected as forthcoming high density recording materials, since they reveal a large perpendicular magneto-crystalline anisotropy. One of the successful methods, which allows to obtain highly ordered alloy, is a subsequent deposition of Fe and Pd layers, followed by annealing at high temperature or another layer mixing e.g. by irradiation.

Experimental Methods

High-resolution Scanning Electron Microscopy (HREM)
Atomic Force Microscopy (AFM)
Rutherford Backscattering Spectrometry (RBS)
X-ray Reflectometry (XRR)

Surface morphology

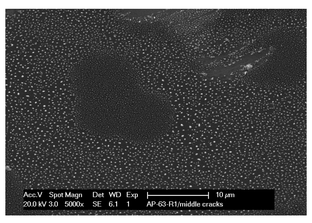
As deposited:

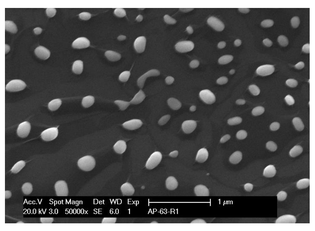


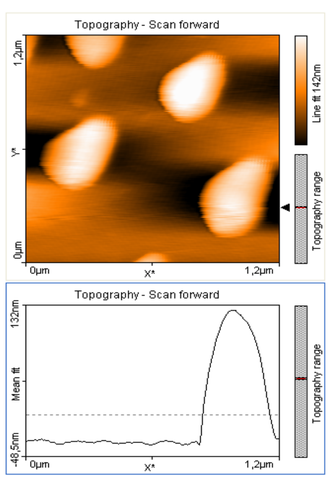
Surface image of as deposited film with single, homogenous Pd or Fe layer

After annealing:

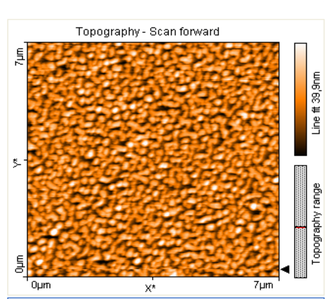
De-wetting process was observed, resulting in creation of regular nanoparticles and islands with sizes about 200-300 nm and heights of 100-150nm.

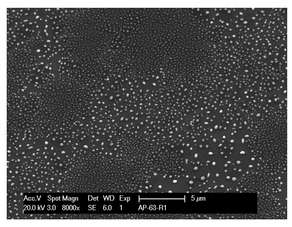


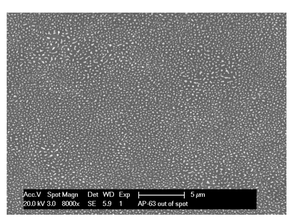




The de-wetting process was observed both for FePd alloy films and for pure Fe and Pd films.

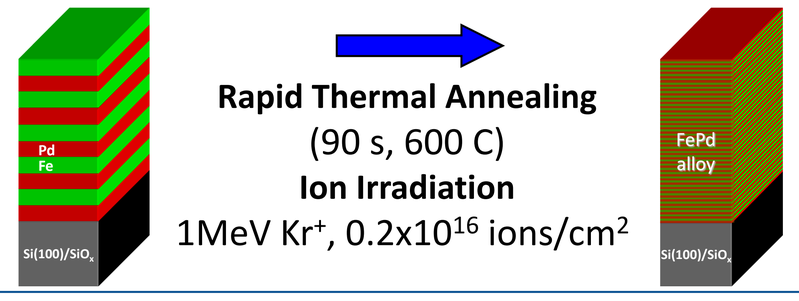






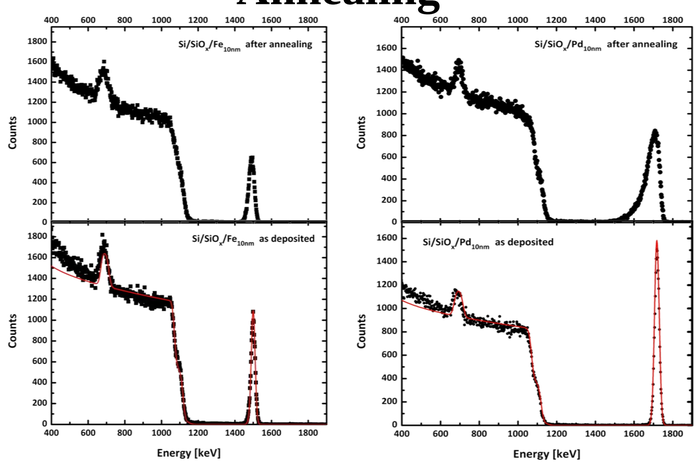
Sample preparation

Sample preparation was done in an ultrahigh-vacuum system at pressures below 10^{-8} Pa. Si(100) wafers, covered by SiO_2, were ultrasonically cleaned in organic solvents and rinsed in deionised water. Fe/Pd multilayers with total thickness of 10 nm have been obtained by sequential thermal evaporation of Fe and Pd in a MBE set-up at rates between 0.2 and 0.5 ML/min and under working pressure in the range of 10^{-7} Pa. Samples with pure Fe and pure Pd layers were deposited in the same conditions. We have investigated the samples in three different states; 1) as deposited, after annealing using Rapid Thermal Annealing (RTA), and after irradiation by 1 MeV Kr^+ ions.



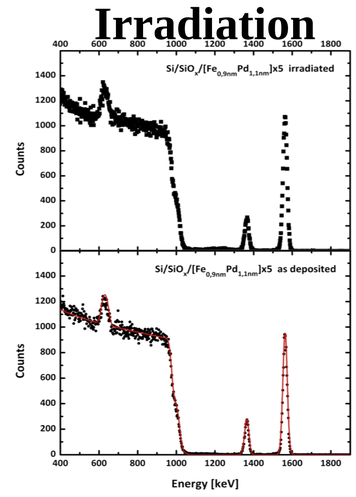
Rutherford Backscattering Spectrometry

Annealing



Annealing leads to the formation of island-structure and/or regular nanoparticles on the film surface. It causes a broadening of the peaks observed in the RBS spectra. This effect is more enhanced in the case of Pd, since this element has a high tendency to de-wetting.

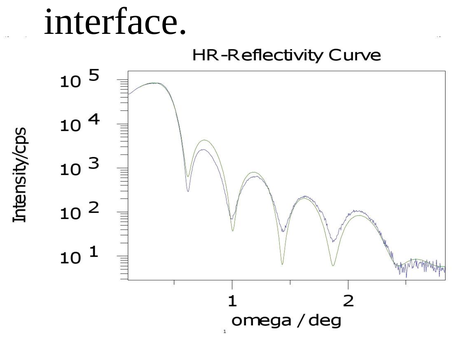
Irradiation



1MeV Kr^+ ion irradiation leads to an interdiffusion at the alloy/substrate interface.

X –ray Reflectometry

XRR analysis provides a layer thickness (9 nm), roughness (0.9 nm for Pd and 0.6 nm for Fe) and density (12.3 g/cm^3 for Pd and 7.9 g/cm^3 for Fe) of each layer.



Conclusions:

1. Thermal annealing induced the creation of $L1_0$ tetragonal structure in FePd thin film alloys.
2. High temperature annealing promoted the alloy de-wetting process, resulting in the formation of regular nanoparticles and islands on the film surface.
3. Interdiffusion at the alloy/substrate interface was observed after irradiation by 1MeV Kr^+ ion beam.

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