Synthesis an characterization of highly ordered Fe_xPd_{100-x} nanowire arrays by template assisted electrodeposition

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Iron-Palladium Alloys are of great scientific and technological interest due to its potential applications as sensors and microactuators [1], in hydrogen separation and membrane hydrogenation reactions [2, 3] and in environmental remediation [4].

Among the most exciting properties of Iron-Palladium alloys it is the magnetic shape memory (MSM) behavior, related to the structural Austenite-to-Martensite reversible phase transitions that can be driven by either varying temperature or applied magnetic field [5]. This implies that Fe-Pd alloys can be used as intelligent/smart thermo-elastic materials for their application in devices based on Giant-Magnetostriction, Magnetoresistance (MR) and Magnetocaloric (MCE) effects [1].

However, bulk thermo-elastic Shape Memory Alloys are not suitable for their use in rapid actuation devices because their response speed is significantly limited by the heat conduction of the material itself. One possibility for overcoming this disadvantage consists of fabricating nanostructured MSM alloys in the form of thin films [6], or as arrays of self-ordered nanowires embedded into nanoporous anodic alumina membranes (NAAM) [7], where high uniaxial shape anisotropy enables FePd nanowires to overcome thermal fluctuations even in very small sizes. Electrochemical deposition has proved its feasibility for synthesizing various functional nanostructured materials [8], whilst up to date, it is so difficult to prepare stable and effective deposition electrolytes of these FePd alloys [6].

In this work, we report on the fabrication process as well as on morphological and magnetic properties of highly ordered Fe_xPd_{100-x} ($11 \leq x \leq 75$) nanowire arrays synthesized by template assisted electrochemical deposition into the pores of NAAMs. Self-assembled nanoporous alumina membranes showing a high-ordering degree were produced by two step anodization process as reported elsewhere [9]. Electrochemical deposition of Fe-Pd nanowire arrays was performed from an aqueous ammonium citrate complex bath [4, 10] keeping the pH value around 9. Structural phases study has been carried out by X-Ray Diffraction measurements. Morphological and compositional characterization was performed by using Scanning Electron Microscopy (SEM) and Electron Dispersive X-ray spectroscopy (EDX), as it can be seen in Fig. **1 a)** and **b)**, respectively. Fig. **2** shows the in-plane and out of-plane hysteresis loops measured in a Vibrating Sample Magnetometer (PPMS-9 T). We search the optimal composition that allows obtaining best MCE effect for magnetic refrigerant devices.

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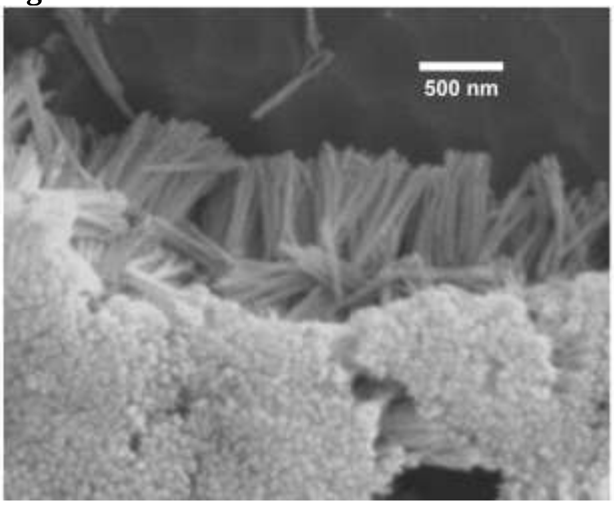
Figures:



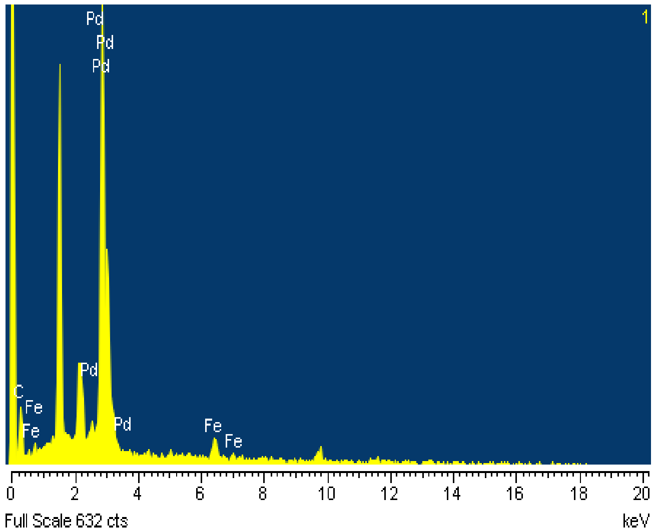


Figure **1**: **a)** SEM Image of Fe-Pd nanowires after removing the AAO template by chemical etching. **b)** EDX spectrum showing the Iron and Palladium composition of nanowires.

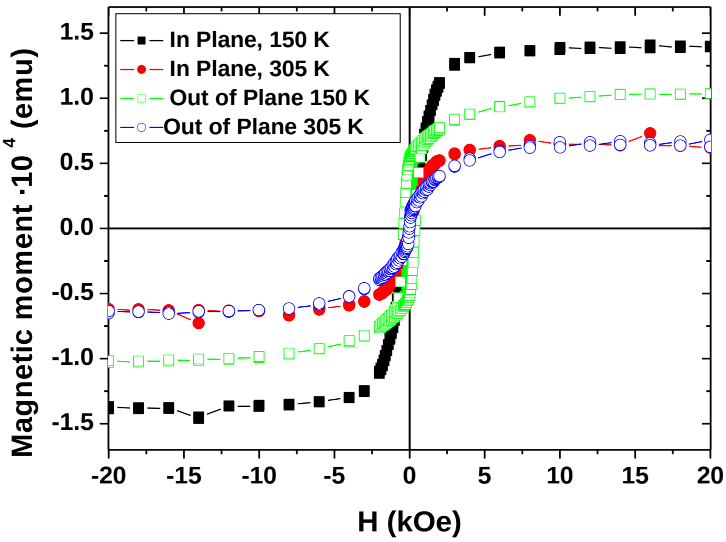


Figure **2**: In plane (full symbols) and out of plane (open symbols) hysteresis loops of Fe-Pd nanowire arrays measured at 150 K and 305 K.

Topics: *Low dimensional materials; Nanomagnetism.*