Optimization of the $Ni_{80}Fe_{20}$ nanoislands growth for sensor technology

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Nickel based alloys have optimal balance of magnetic and functional properties. The particular interest in quasi-2D structures near the percolation region for fundamental investigation and spintronic application is caused by the demonstration of unique magnetic phenomena like skyrmions and vortex-antivortex pairs. The use of pulsed electrodeposition with ultra-short pause duration make it possible to produce nanocrystalline films with controlled grain size and may have impact on the mechanism of their growth. However, the influence of processes, which occur during the pause between pulses, remains important for the growth mechanism. We studied occurring processes during the interpulse relaxation (IPR) time and their influence on the growth mechanism and the structure of the final NiFe films. As a result, three types of NiFe films with an absolutely different structure can be obtained for electrolyte deposition regimes with a fixed pulse duration and with an increase in the IPR time due to controlled conglomeration of nanocrystallines with excess surface energy. So, the uniform nanocrystalline NiFe film with an average grain size less than 10 nm was obtained in the short relaxation (SR) regime (shortest IPR time) of pulsed electrodeposition. The uniformly distributed fraction of grains conglomerations (40 – 50 nm) surrounded by nanosized grains (less than 10 nm) was observed using medium relaxation (MR1 and MR2) regimes. Finally, using large relaxation (LR) regime with the largest IPR time, separate "islands" with a size about 50 nm were formed on the gold sublayer. So, we have shown the possibility of transition of the growth mechanism from the layer-by-layer through the layer-plus-island to island formation by varying only one technological parameter – IPR time. We first showed the ability to control the mechanism of the NiFe films growth by controlled nanocrystallites conglomeration during pulsed electrolyte deposition. This opens broad perspectives for practical applications of this technology.

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