Magnetic Co-containing ultrathin layered structures: from magnetic nanodots to magnonic crystals

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Magnetic anisotropy that determines magnetization orientation in ultrathin layered structures strongly depends on the Co layer thickness and a type of adjacent non-magnetic films. For Au or Pt covers the Co layer exhibits perpendicular magnetic anisotropy (PMA) at the small thicknesses (below 2 nm). In the range of bigger thicknesses magnetization is oriented in the sample plane [1]. Moreover, due to the structure and lattice parameter mismatch at the interfaces (e. g. bcc-Mo(110)/hcp-Co(0001)) additional in-plane anisotropy may be induced [2]. Suitable choice of the Co layer thickness and the type of adjacent films enables to engineer magnetic properties of such structures in a desired way.

In this talk I will review diversity of magnetic properties, described below, observed in ultrathin layered structures fabricated and investigated in my laboratory.

Deposited Au at elevated temperatures on Mo surface forms self-assembled islands several tens of nanometer in size [3]. Such patterned buffer allows to fabricate by Co layer deposition a net of magnetic nanodots magnetized in perpendicular direction and embedded in the matrix with magnetization aligned in the sample plane [4]. Observed magnetization reversal of monodomain dots is modelled in micromagnetic simulations [5].

Irradiation of layered structures substantially modifies their magnetic properties. Irradiation with 30 keV Ga ions with increasing fluence sequentially switches in Pt/Co/Pt sandwiches their magnetization between in-plane and perpendicular directions [6]. Similar effect is observed upon laser irradiation [7]. Such behaviour is a consequence of interplay between induced strains, degradation of the interfaces and creation of alloys with strong PMA.

Magnetization and interlayer coupling in Co/Mo/Co multilayers depends on the Co layer and Mo spacer thicknesses and a type of outer layers. For Au covers magnetization is oriented in perpendicular direction and the coupling oscillates between parallel (P) and antiparallel (AP) configurations with Mo spacer thickness increase. Mo covers force in-plane magnetization and additional two-fold anisotropy. Magnetization and the coupling in Mo/Co/Mo/Co/Mo sandwiches were modified by ion (Ga, Ar, Ne) irradiation [8]. Changes in the coupling (AP-P crossover) are associated with evolution of the layered structure deduced from the numerical simulations performed with help of TRIDYN package. Combination of the observed modifications and a focused ion beam technique is a straightforward approach towards fabrication of three-dimensional magnonic crystals.

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