Energy harvesting from low dimensional systems: Anomalous Nernst effect on Co/Pt multilayers

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The anomalous Nernst effect (ANE) is a thermoelectric effect that can be exploited for energy harvesting to make use of wasted thermal energy from natural sources or from different electronic devices. The effect depends on the direction of the magnetization of the sample with respect to the direction of a thermal gradient. Thus, in order to maximize the spontaneous ANE, i.e. without applying any external field, it is very convenient to have the remanence of the system in a well-defined direction. Here we report on the ANE response of microscopic devices based on multilayers of Co/Pt with high perpendicular magnetic anisotropy. We fabricated micrometre sized devices to enhance the thermal gradient and achieve high efficiency thermoelectric devices. Consequently, the thermal decay occurs across a very small space, giving thermal gradients three orders of magnitude higher than the achieved in macroscopic devices. We extracted the magnetization of the microscopic structures from magnetic force microscopy (MFM) images. We also measured the maximum current and power provided by the device. We obtained record voltages of approximately 30 mV/cm and power densities of around 10 W/cm^3. This work tries to emphasize the importance of evaluating the resistance or the maximum current admitted by materials with high ANE for energy harvesting purposes. We also suggest the miniaturization of ANE based devices to obtain high efficiencies.

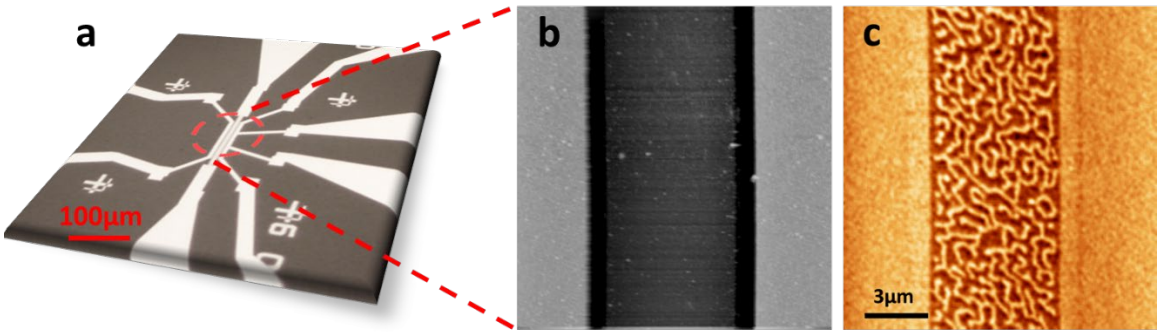

Figure 1. a) Picture of the device used to measure the ANE thermopower of microscopic multilayers. b) Atomic Force microscopy and c) MFM images of the magnetic multilayer without remanent magnetization, showing the worm-like structure of the magnetic domains.