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Development of low-depolarizing CuTi neutron supermirrors

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Neutron supermirrors are multilayer structures of varying bilayer thickness with the purpose of extending the critical angle of the coating, increasing the neutron flux reaching the neutron instruments. The sputtered layers of the supermirrors are mostly made of nickel and titanium due to their excellent scattering contrast. Depolarization effects due to the ferromagnetism of nickel are routinely suppressed to well below 1% by molybdenum alloying. However, a new generation of instruments measuring the angular correlation coefficients in ß-decay of free polarized neutrons require neutron guides exhibiting depolarization below 10-3.

In the last years the neutron optics group of FRM II has successfully sputtered a 190-layer non-depolarizing m=2 CuTi supermirror produced by standard DC magnetron sputtering. Control of the roughness growth and interdiffusion allowed us to get a maximum angle of total reflection of 0.21°/λ and polarized neutron reflectivity above 90%, as measured at the instrument GINA (BNC). The CuTi coating was checked by means of SQUID measurements at the WMI (Garching) to be slightly ferromagnetic with magnetic moment of 2×10-3 emu/cm3, compared to 500 emu/cm3 of NiTi and 0.1 emu/cm3 of Ni(Mo)Ti supermirrors.

Recent depolarization measurements performed at the PF1B beamline (ILL) using the Opaque Test Bench setup excluded depolarization of a fully polarized neutron beam after a reflection on the CuTi supermirror in the range of 10-4.

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