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Polarizing neutron optics with higher reflectivity, polarization and no magnetic coercivity

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Neutron supermirrors are the bedrock of all modern neutron beamlines both polarized and unpolarized. However, while the technology has improved remarkably over the last 20 years there are still areas where significant improvements can be made regarding interface roughness reduction, better polarization and elimination of magnetic stray fields when polarizing the neutrons. Adding 11B4C to Fe/Si supermirrors has potential to alleviate some of these issues. Boron has been shown to form metal-boron bonds which restricts metal diffusion which, in turn, inhibits metal crystallite formation during DC magnetron sputter deposition. Element-pure Fe/Si multilayers inherently exhibit large interface widths due to crystallization of Fe layers and Fe-silicides at the interfaces. It has been shown that incorporation of 11B4C helps reducing the interface width as it promotes amorphization in Fe layers due to Fe-B bonding and reduces diffusion at the interfaces to suppress Fe-silicide crystallization. In this work, isotope enriched 11B is used since; (a) 10B is a widely known neutron absorber and (b) a high scattering length density (SLD) of 11B4C can be used to maximize polarization by maximizing the SLD contrast for one spin state while minimizing it for the other spin state by compositional variation of 11B4C in the Fe and Si layers. Through X-ray and neutron scattering-, magnetometry-, microscopy- and spectroscopy techniques we prove our case that Fe/Si + 11B4C would be of preference.

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