

Interface Growth in FeCo-Si Multilayers determined with atomic resolution

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FeCo-Si multilayer systems can be used as neutron polarisers due to the matching of their scattering length densities for one spin component. To optimise their performance, the thickness of interface layers should be as small as possible. For this purpose a model system was built and characterised by several methods.

Polarized neutron reflectometry is used to characterise a model system of a monochromator with 5 bilayers of nominally 100 Å Si and 100 Å Fe₈₉Co₁₁ covered with a final layer of 100 Å Si to prevent oxidation of the Fe₈₉Co₁₁ layer. From these data it was possible to determine the thickness and composition of the interface layers.

The values of these properties depend on the sputtering parameters. Under the conditions of minimal thickness of the interface layers neutron reflectometry showed on top of the silicon layer 15 Å (Fe₈₉Co₁₁)_{0.51}Si_{0.49} and on top of the iron cobalt layer 18 Å (Fe₈₉Co₁₁)_{0.67}Si_{0.33}. The errors are in the thickness ± 2 Å and in the composition $\pm 2\%$.

Additional measurements with in situ fast kinetic ellipsometry and x-ray scattering agree with the neutron results within the error limits.

In situ fast kinetic ellipsometry allows investigating the growth of sputtered Fe₈₉Co₁₁-Si multilayers, revealing that during growth the iron cobalt layer undergoes a phase transition. After the formation of the interface layer on top of the silicon layer the iron cobalt alloy starts to grow in an amorphous phase until a thickness of 25 Å is reached. Then it crystallizes down to the interface layer whereby it shrinks to 18.5 Å. The atomic density changes nearly proportionally to the imaginary part of the index of refraction.

Using all these data it was possible to describe the growth of the multilayer system with atomic resolution.

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