Interface mixing of Fe/Si bilayers by noble-gas ions: effects of the ion charge-state and low-energy Ar ion pre-amorphization of Si substrates

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Abstract. Ion beam mixing of Fe/Si bilayers, induced by 100 keV ^{40}Ar, 180 keV ^{86}Kr and 250 keV ^{132}Xe ions at room temperature, was investigated. Rutherford backscattering spectroscopy (RBS), scanning electron microscopy (SEM) and transmission electron microscopy (TEM) were applied for structural characterization. The study focuses on the influence of the ion charge state and the substrate structure on interface mixing. The mixing rates were determined as a function of the ion charge, by considering singly and multiply charged ions (Ar^{8+}, $Kr^{11+}$and Xe^{17+}) of the same energy. The influence of the substrate structure comprises of two classes of irradiated bilayers, Fe thin films deposited on crystalline or pre-amorphized Si substrates.

Charge-state equilibration of ions moving in matter occurs within femtoseconds and when penetrating nanometer depths. Ion beam mixing bilayers, tens of nm thick, should therefore not depend on the charge state of the projectiles. No significant influence of the ion charge-state was observed for Kr and Xe ions, although slightly higher mixing rates were found for Ar^{8+} than for Ar^{1+} irradiation [1]. On the other hand, an about 76% higher efficiency of atomic transport across the pre-amorphized Fe/a-Si interface as compared to that of Fe/c-Si bilayers was observed for all ions [2]. The deduced mixing rates for the Fe/c-Si samples are in agreement with the predictions of the local spike model.

REFERENCES

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