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Atomic Scale Understanding of the Surface Intermixing during Thin Metal Film Growth

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Thin multilayer structures in nanometer scale are widely used in many advanced devices and sensors. In order to optimize the performance of these devices, control of the interface in atomic scale is crucial, which needs in-depth understanding of the atomistic intermixing behavior during early stage of thin film deposition. We investigated the atomic scale deposition behavior in Co-Al system by a molecular dynamics simulation using semi-empirical EAM potentials. Atoms of kinetic energy 0.1eV were deposited on single crystal substrates at 300K. Asymmetric intermixing was observed: severe intermixing occurs when Co was deposited on Al substrate while an atomically sharp interface forms between Al film and Co substrate. Kinetic criteria of the asymmetric intermixing phenomena will be discussed based on the in-depth analysis of the molecular dynamic simulations. In addition to the previous experimental observations, this asymmetric intermixing behavior was also confirmed by low energy ion scattering analysis and MOKE measurement of 0.5 monolayer deposited on single crystal substrate. We also suggested a novel process for high performance spin valve devices based on this asymmetric intermixing phenomenon.