Growth and magnetic properties of artificial $L1_0$ Fe-Co alloy

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Iron-cobalt alloys are of interest due to their high magnetic moment and Curie temperature, and to the strong magnetic character of both constituents. In bulk, Fe and Co are totally miscible, with B_2 structure being the only ordered alloy phase. In this work, we use modern laser molecular beam epitaxy to artificially grow a new ordered Fe-Co alloy phase, i.e., $[Fe(1ML)/Co(1ML)]_n$ $L1_0$ phase, which consists of alternatively stacked monatomic layers of Fe and Co. By monitoring reflection high energy electron diffraction (RHEED) oscillations during the growth, precise amounts of iron and cobalt were deposited onto a Cu(001) single crystal substrate in ultrahigh vacuum. In-situ scanning tunneling microscopy images showed almost perfect layer-by-layer morphologies, while low energy electron diffraction (LEED) patterns and Auger electron spectroscopy data collected after each whole layer deposition showed that the fcc phase with layered composition was preserved up to seven monolayers. Ex-situ X-ray diffraction results include new diffraction features confirming the existence of the Fe-Co $L1_0$ alloy. The magneto-optic Kerr effect (MOKE) results showed that the alloy was ferromagnetic with easy axis in plane. After seven monolayers deposition a structural change was observed by LEED and RHEED, and was reflected in a dramatic increase in coercivity and Curie temperature observed in the MOKE study.

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