A. P. Baddorf and J. F. Wendelken
SSD, Oak Ridge National Laboratory
C. T. Venkataraman and T. Gog
CMC-CAT, Argonne National Laboratory

Oriented Quantum Dots By Buffer Layer Growth Process

Quantum dots of Fe formed by a multi-step growth process are shown to be highly oriented on a Cu(100) substrate. Growth involved deposition of Fe on a buffer of ~200 layers of condensed Xe. The Xe buffer layer, which promotes clustering, was subsequently removed by heating. In situ scanning tunneling microscopy results reveal formation of 3-D Fe clusters averaging ~10 nm in diameter. An additional ~20 nm thick cap of Cu was deposited over the Fe to allow ex situ x-ray studies at the Advanced Photon Source. Fe clusters were found to be highly oriented, with the close-packed [110] direction normal to the Cu(100) surface and with two in-plane orientations. The first in-plane structure has Fe {-112} planes aligned with Cu {001} and the second has Fe {-110} planes aligned with Cu {001}. These orientations are not observed in molecular beam epitaxy of Fe directly onto Cu(100) or in precipitate growth. Buffer layer growth bypasses the intermediate fcc Fe phase formed by direct deposition on fcc Cu and brings bcc Fe immediately into contact with fcc Cu. Sidestepping the fcc Fe phase may allow the newly observed orientations.

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