Generic Buffer Layers for Fe-based Superconductors: Epitaxial $FeTe_{1-x}Se_x$ Thin Films

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Abstract - Iron chalcogenide superconductors are very sensitive to strain. Hence the superconducting transition temperature, T_c, of $FeTe_{1-x}Se_x$ films can be tuned by strain and even higher T_c values can be realized in films than in bulk material. The biaxial strain is usually induced by a lattice mismatch between film and substrate. However, the correlation between T_c and lattice mismatch for $FeTe_{1-x}Se_x$ is controversial. A fundamental problem is the formation of an interfacial layer between $FeTe_{1-x}Se_x$ and oxide substrates, which compromises the epitaxial growth. Therefore, we proposed the implementation of a Fe buffer layer to grow epitaxial $FeTe_{1-x}Se_x$ thin films. Similar to the Ba-122/Fe bilayers, 1) epitaxial $FeTe_{1-x}Se_x$ films with sharp out-of-plane and in-plane texture have been realized on Fe-buffered single crystalline MgO substrates. 2) The clean interface between Fe and $FeTe_{1-x}Se_x$ has been also confirmed by transmission electron microscopy. These results indicate that Fe can work as generic buffer layer for epitaxial growth of Fe-based superconductors. The $FeTe_{1-x}Se_x$/Fe bilayer with a high T_c of 19 K showed strong intrinsic pinning from correlated *ab*-planes, since the Se(Te)-Se(Te) interlayer distance is almost identical to the out-of-plane coherence length at low temperatures. This work is partially supported by DFG. Project, No. BE 1749/13 and HA 5934/3-1. We also acknowledge the EU (IRON-SEA and SUPERIRON) under project No. FP7-283141 and FP7-283204. A portion of this work was performed at the National High Magnetic Field Laboratory, which is supported by National Science Foundation Cooperative Agreement No. DMR-0654118, the State of Florida, and the U.S. Department of Energy.

Keywords – Fe-based superconductors, $FeTe_{1-x}Se_x$, thin film, epitaxy, buffer layer, iron buffer.

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