Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Simultaneous measurement of pressure evolution of crystal structure and superconductivity in Fese$_{0.8}$ using designer diamonds WALTER UHOYA, University of Alabama at Birmingham (UAB) Birmingham, AL 35294, USA, NATHANIEL WOLANYK, Illinois Wesleyan University (IWU), Bloomington, IL 61702-2900, USA, GEORGIY TSOI, University of Alabama at Birmingham (UAB) Birmingham, AL 35294, USA, YOGESH VOHRA, Department of Physics, University of Alabama at Birmingham (UAB) Birmingham, AL 35294, USA, SISTLA M RAO, MAU-KUEN WU, Institute of Physics, Academia Sinica, Nankang, Taipei 115, Taiwan, SAMUEL WEIR, Mail Stop L-041, Lawrence Livermore National Laboratory (LLNL) Livermore, CA 94550, USA — Simultaneous high pressure x-ray diffraction and electrical resistance measurements have been carried out on (P4/nmm) PbO type α-FeSe$_{0.89}$ compound to a pressure of 44 GPa and at low temperatures down to 4 K using a synchrotron source and designer diamond anvils technique. At ambient temperature, a structural phase transition from the tetragonal (I4/nmm) phase to orthorhombic (Pbnm) is observed at 11 GPa and persist up to 75 GPa. The superconducting transition temperature increases rapidly with pressure in a parabolic manner reaching a maximum of $\sim$40 K at $\sim$ 11GPa. It then decreases at higher pressures. We also performed a complimentary pressure dependence x-ray diffraction simultaneously with resistance measurement at low temperatures and observe superconductivity only in the low pressure orthorhombic phase (Cmma) of α-FeSe$_{0.89}$ Upon increasing pressure at 10 K, structural phase change from a mixed phase of orthorhombic (Cmma) and hexagonal (P63/mmc) to a high pressure orthorhombic phase (Pbnm) is observed at around 12 GPa where Tc is maximum.

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Date submitted: 20 Nov 2011 Electronic form version 1.4