Highlights

ACTIVITY A Novel superconducting and functional materials for energy and environment - 2020

The uncollapsed $LaFe_2As_2$ phase: compensated, highly doped, electron-phonon coupled, iron-based superconductor

I. Pallecchi [1], A. Iyo [2], H. Ogino [2], M. Affronte [3], M. Putti [4,1]

[1] CNR-SPIN, UOS-Genova, c/o Dipartimento di Fisica, via Dodecaneso 33, 16146 Genova, Italy
[2] National Institute of Advanced Industrial Science and Technology (AIST), 1-1-1 Umezono, Tsukuba, Ibaraki 305-8568, Japan
[3] Dipartimento di Scienze Fisiche, Informatiche e Matematiche, Università degli Studi di Modena e Reggio Emilia, and CNR-NANO, via G. Campi, 213/A, 41100 Modena, Italy
[4] Università di Genova, Dipartimento di Fisica, via Dodecaneso 33, 16146 Genova, Italy

PHYSICAL REVIEW MATERIALS 4, 114803 (2020)

The recently discovered $LaFe_2As_2$ superconducting compound, member of the 122 family of iron pnictide superconductors, becomes superconducting below $T_c \approx 13K$, yet its nominal doping apparently places it in the extreme overdoped limit, where superconductivity should be suppressed. In this work, we investigate the normal state of magneto- and thermo-electric transport and specific heat of this compound. The experimental data are consistent with the presence of highly compensated electron and hole bands, with ~0.42 electrons per unit cell just above T_c, and high effective masses ~$3m_0$. The temperature dependence of transport properties strongly resembles that of conventional superconductors, pointing to a key role of electron-phonon coupling. From these evidences, $LaFe_2As_2$ can be regarded as the connecting compound between unconventional and conventional superconductors.

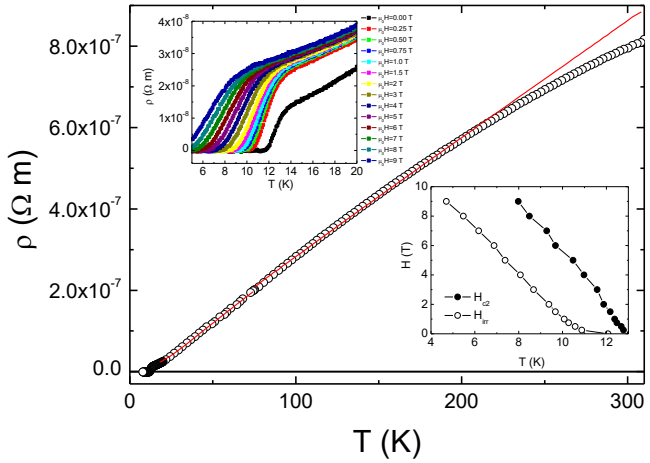

Fig. 1: Resistivity of $LaFe_2As_2$. The red line represents the fit with the generalized Bloch-Grüneisen law. The high temperature departure. Close to room temperature, the experimental curve bends with respect to the Bloch-Grüneisen law, as typical of metals with large electron-phonon coupling, when the mean free path decreases and approaches the lattice spacing. Upper left inset: resistivity curves in different magnetic fields up to 9 T. Lower right inset: Critical fields H_{c2} and H_{irr} extracted from the resistive transitions.

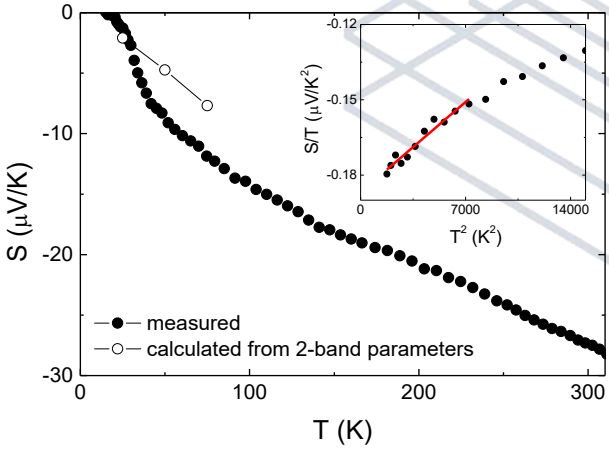

Fig. 2: Measured Seebeck coefficient of $LaFe_2As_2$ (filled symbols). The diffusive contribution to the Seebeck coefficient, calculated from the two-band parameters, is also shown in the main panel (open symbols). Inset: S/T versus T^2 plot, with a linear regime identified in correspondence of the temperature range 40-85K, which identifies the phonon drag Seebeck coefficient, related to the large electron-phonon coupling.