A possible unusual superconducting state up to 49 K in single crystalline R-doped $CaFe_2As_2$ (Ca122) at ambient with R = rare earth

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The discovery in 2008 of the Fe-pnictide and Fe-chalcogenide superconductors have generated immense interest. The highest T_c of these compounds is 57 K in the 1111 structure class with electron-doping at ambient or under pressure. Until now, no effort has been successful to raise the maximum T_c of Fe-pnictides or -chalcogenides to above the 60s K as predicted. We have detected superconductivity up to 49 K in single crystalline $CaFe_2As_2$ via electron-doping by partial replacement of Ca by rare-earth. The superconducting transition observed suggests the possible existence of two phases: one starts at $\sim$ 49 K and the other at $\sim$ 21 K, with drastically different responses to field. Our observations are in strong contrast to previous reports of hole-doping or pressurizing layered compounds $Ae Fe_2As_2$ (or Ae122), where Ae = Ca, Sr or Ba with a maximum T_c of 38 K. The unusual 49 K phase observed appears to be filamentary or interfacial in nature. The associated superconducting transition at 49 K behaves as Josephson-Junction-coupled-like, suggesting the existence of a superconducting phase above 49 K in the R-Ca-Fe-As compound system. The results will be presented and the implications discussed.

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