Highlights

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Transport and Point Contact Measurements on $Pr_{1-x}Ce_xPt_4Ge_{12}$ Superconducting Polycrystals

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We performed a detailed investigation of the superconducting properties of polycrystalline $Pr_{1-x}Ce_xPt_4Ge_{12}$ pellets. We report the effect of Ce substitution, for x = 0.07, on magnetic field phase diagram H-T. We demonstrate that the upper critical field is well described by the Ginzburg–Landau model and that the irreversibility field line has a scaling behavior similar to cuprates. We also show that for magnetic fields lower than 0.4 T, the activation energy follows a power law of the type $H^{-1/2}$, suggesting a collective pinning regime with a quasi-2D character for the Ce-doped compound with x = 0.07. Furthermore, by means of a point contact Andreev reflection spectroscopy setup, we formed metal/superconductor nano-junctions as small as tens of nanometers on the $PrPt_4Ge_{12}$ parent compound (x = 0). Experimental results showed a wide variety of conductance features appearing in the dI/dV vs. V spectra, all explained in terms of a modified Blonder–Tinkham–Klapwijk model considering a superconducting order parameter with nodal directions as well as sign change in the momentum space for the sample with x = 0. The numerical simulations of the conductance spectra also demonstrate that s-wave pairing and anisotropic s-waves are unsuitable for reproducing experimental data obtained at low temperature on the un-doped compound. Interestingly, we show that the polycrystalline nature of the superconducting $PrPt_4Ge_{12}$ sample can favor the formation of an inter-grain Josephson junction in series with the point contact junction in this kind of experiments.

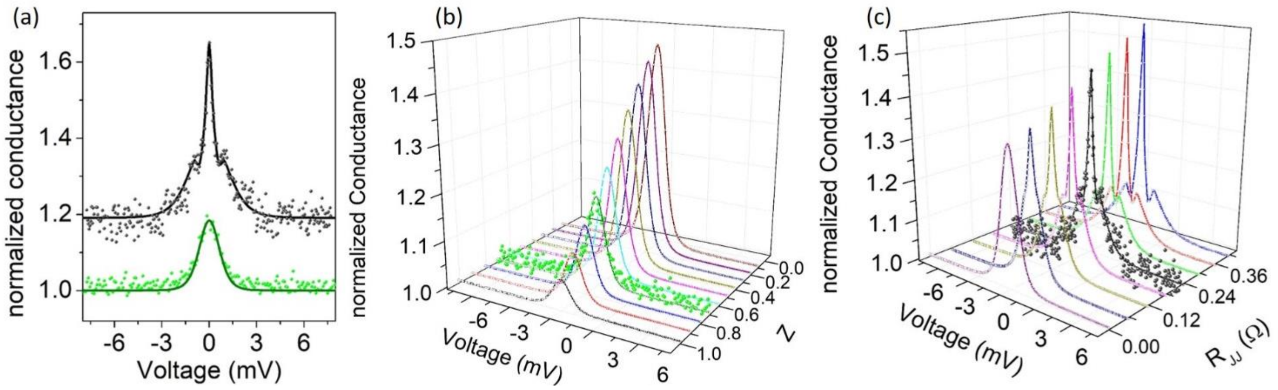

Fig.1. (a) Conductance spectra measured (green data) soon after the tip approach on the surface. The upper (black) spectrum was measured after increasing the tip pressure on the surface. (b) Evolution of conductance spectra calculated numerically for $\Delta = 0.55$ meV and for $0 < Z < 1$. (c) Evolution of conductance spectra calculated for $\Delta = 0.55$ meV, Z = 0.39, $\alpha = 0.29$, and $0 < R_{JJ} < 0.42\ \Omega$.