Intercalant-independent transition temperature in superconducting intercalated black phosphorus

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Abstract
Research on black phosphorus (BP) has been experiencing a renaissance in the last few years, after the demonstration that few-layer BP exhibits high carrier mobility and a thickness-dependent band gap[1,2]. For a long time[3], bulk BP is also known to be a superconductor under high pressure exceeding 10 GPa. The superconductivity is due to a structural transformation into another allotrope of phosphorous[3,4] and accompanied by a semiconductor-metal transition[3]. No superconductivity could be achieved for BP itself (that is, in its normal orthorhombic form) despite several attempts reported in the literature[5,6]. Here we describe successful intercalation of BP by several alkali metals (Li, K, Rb, Cs) and alkali-earth Ca. All the intercalated compounds are found to be superconducting, exhibiting exactly the same critical temperature of 3.8±0.1 K and practically identical characteristics in the superconducting state. Such universal superconductivity, independent of the chemical composition, is highly unusual. We attribute it to intrinsic superconductivity of heavily-doped individual phosphorene layers, while the intercalated layers of metal atoms only play a role of charge reservoirs.

References

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Figures

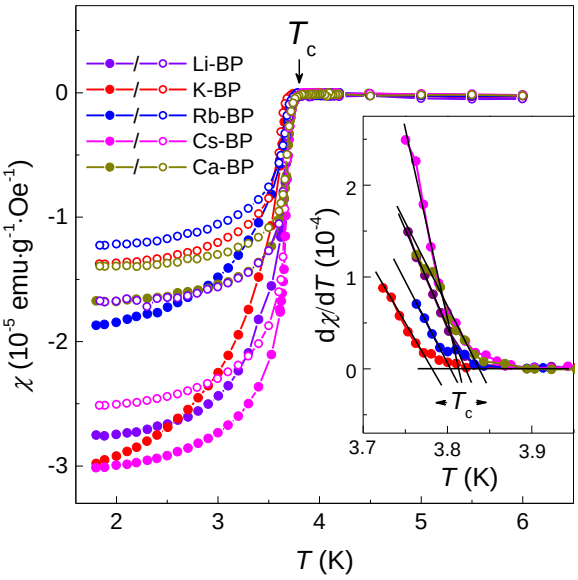

Figure 1: Superconductivity in intercalated black phosphorus. Temperature dependence of magnetic susceptibility χ for Li, K, Rb, Cs and Ca intercalation. Inset show the corresponding numerical derivative dχ/dT. T_c is determined as the temperature corresponding to a sharp increase in dχ/dT and is given by a crossing point of the linear extrapolations of the corresponding parts of the curve.