

Superconductivity in aromatic hydrocarbon picene

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We discovered superconductivity by intercalating K and Rb atoms into picene crystals in which the molecule consists of five benzene rings (Fig. 1). The superconducting transition temperature T_c of 20 K was recorded in K_x picene ($x \sim 3$), which is the highest T_c observed in organic superconductors; the shielding fraction

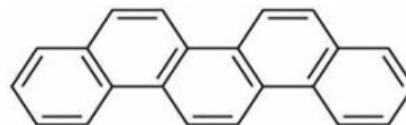


Figure 1. Molecular structure of picene.

was $\sim 1\%$. Rapid decrease in magnetization M was observed below 20 K, and it substantially reaches a minimum value within 1 K. This behavior is similar to that in Ca intercalated graphite CaC_6 , which shows the superconducting critical temperature, T_c , of 11.5 K [1]. Plots of M versus magnetic field H shows the lower critical magnetic field H_{c1} of ~ 380 Oe and the upper critical field H_{c2} of $> 10^4$ Oe at 5 K. These values are also similar to those ($H_{c1} \sim 600$ Oe and $H_{c2} \sim 2000$ Oe) of CaC_6 [1]. The X-ray diffraction pattern of $K_{2.9}$ picene shows the lattice constants, a , b and c of 8.707(7), 5.912(4) and 12.97(1) Å and β of $92.77(5)^\circ$, suggesting only a slight expansion of crystal lattice along a direction in the plane of two dimensional picene layer. The K atoms may be located in the layer (not interlayer), and the herringbone structure in picene crystals may be deformed by K intercalation between the molecules in the layer. The $H - T$ plots also shows the H_{c1} of ~ 380 Oe (the plots corresponds to $H_{c1} - T$ plot). The superconducting transition was observed only for $x \sim 3$, and the Pauli paramagnetism was observed for $x < 2$, indicating a normal metallic behavior for K_x picene ($x < 2$). Rb_3 picene showed superconducting transition at 7 K and the shielding fraction was $> 10\%$. From the DFT calculation of picene, the LUMO+1 level in picene is singly occupied and the LUMO and LUMO+1 levels in picene are close to each other, which suggests very high density of states.

[1] N. Emery *et al.* *Phys. Rev. Lett.* 95, 087003 (2005).