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Superconducting cobalt in nanoscale cobalt thin films

The phenomenon of superconductivity was discovered over a century ago. So far more than half of the number of elements in the periodic table has shown superconductivity. Usually metals possessing strong long-range magnetic order, as in anti-ferromagnetism or ferromagnetism, do not exhibit superconductivity. This includes cobalt, a ferromagnetic transition metal. Recently, we discovered a high-Density Nonmagnetic (HDNM) fcc phase of Co-in Co thin films. As this phase of Co is nonmagnetic, it was logical to explore superconductivity in this HDNM phase of Co. We have indeed discovered superconductivity in these HDNM Co thin films with a superconducting transition temperature (Tc) of ~5 K. The transition to the superconducting state has been detected by four-probe measurements. Point-contact spectroscopy has provided a Tc value of ~9.5 K. The higher value of Tc obtained in point contact spectroscopy is apparently due to unavoidable pressure at the contact point. First-principles density functional theory calculations for this dense fcc phase of Co show that this phase is nonmagnetic, characterized by zero elementary moment, and the estimated TC within the BCS theory is 0.30 K. A volume preserving strain in fcc Co is shown to result in anomalous softening of zone boundary phonons which couple strongly with electrons and stabilize superconductivity at a relatively high temperature (>5 K). The value of TC can indeed be higher for other strain conditions. That the superconducting Co layer (~4 nm) is in contact with a ferromagnetic Co layer (18 nm) indicates its potential application in the area of quantum information.

Biography

Bhupendra Nath Dev has completed his PhD from University at Albany, The State University of New York, USA and Postdoctoral studies at DESY, Hamburg, Germany. He has supervised 21 PhD theses and published about 160 papers in reputed journals. He has been serving as an Editorial Board or Advisory Editorial Board Member of several international journals.

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