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Unconventional pressure dependence of the superfluid density in topological superconductor α−PdBi2

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The Pd-Bi family of compounds has become quite popular system to explore topological superconductivity due to their intrinsic capability to maintain strong spin orbit coupling (SOC). Amongst various members of this family, α-PdBi$_2$ turns out to be very promising due to its superconducting (T_c = 1.7 K) as well as topological properties such as Dirac point at 1.26 eV below the Fermi energy at the zone center, Rashba state near the Fermi energy etc. Notably, the ARPES data display multiple band crossings at the Fermi energy which signals a possible multiple gap superconducting gap structure in this compound. To explore this interesting aspect, we investigated the superconducting properties of the topological superconductor α-PdBi2 at ambient and external pressures up to 1.77 GPa using muon spin rotation (μSR) experiments. The ambient pressure μSR measurements demonstrate a fully gapped s-wave superconducting state in the bulk. The observation of s-wave superconductivity in α-PdBi$_2$ is quite crucial in search for Majorana fermions as it is theoretically predicted that in presence of an in-plane magnetic field, the Majorana zero mode can be realized utilizing the coupling of an s-wave superconductor with a material exhibiting Rashba states. Further, AC magnetic susceptibility and μSR measurements under hydrostatic pressure manifest a continuous suppression of T_c with increasing pressure. We observed a considerable decrease of superfluid density by ~20% upon application of external pressure. Remarkably, the superfluid density follows a linear relation with T_c which was found before in some unconventional topological superconductors and hole doped cuprates. This finding indicates a possible crossover from Bose-Einstein to Bardeen-Cooper-Schrieffer like condensation in α-PdBi$_2$.

Reference

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