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Superconducting Property of Antiperovskite $MgCNi_3$

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$MgCNi_3$ has anti-provskite structure where C-Ni_6 octahedron forms the crystal building block. In 2001, He *et al* found that it superconducts at Tc = 8K. Since then, there has been controversy on the origin of the superconductivity of this material. Tunneling measurement shows the zero conductance peak (ZCP) which is suggestive of non-s-wave BCS superconductor. Theoretically, Rosner *et al* emphasized that $MgCNi_3$ is in close vicinity with the ferromagnetic Ni metal and proposed spin fluctuation induced unconventional p-wave pairing. On the other hand, the conventional BCS mechanism is also supported by both experiment and theory. In this work, we have performed X-ray photoemission spectroscopy, infrared spectroscopy, and muon spin rotation experiment. The mSR measurement shows that the penetration depth depends exponentially on temperature below Tc. This behavior is well fit with the BCS formulation with the intermediate coupling constant $\lambda=0.8$. Also, we have synthesized $(Mg_{1-x}Zn_x)CNi_3$ and found that the lattice constant and Tc changes systematically with the Zn-content x. Theoretical analysis shows that the result is well explained in the electron-phonon coupled s-wave BCS scheme.

keywords :pairing symmetry, spin fluctuation, BCS mechanism