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Tuning of physical properties by chemical doping of semiconductor oxide

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The interest in gapless semiconductors has been persistent from the studies of early gapless materials such as HgCdTe. Because of the exotic band structure they show very interesting change in the physical properties. Theoretically, PbPdO2 was proposed to be a gapless semiconductor.In addition, by doping Pd with Co ions the material becomes a spin gapless semiconductor which has full spin polarization. This may give a promising future in spintronics applications.

In this study we have experimentally shown the changes in the physical properties of PbPdO2 by doping Pd with different magnetic ions such as Co, Mn, and Zn.$PbPdO_2$ shows a metal-insulator-like transition at TMI=100K in the resistivity vs. temperature measurements. The magnetic properties show a diamagnetic behavior at high temperatures and a ferromagnet-like behavior at low temperatures. The TMI increases to 150K by Co doping and the diamagnetic behavior changes to paramagnetic behavior. By Mn doping, the TMI decreases to 73K and the magnetic behavior changes drastically to show antiferromagnetic ordering at low temperatures. However no difference has been found by Zn doping. The common feature for all materials is that the charge carrier density increases with doping. These observations are in close relation to the orbital configuration of the doping ions.