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Metal-insulator transitions of bulk and domain-wall states in pyrochlore iridates.

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A family of pyrochlore iridates $R_2Ir_2O_7$ offers an ideal platform to explore intriguing phases such as topological Mott insulator and Weyl semimetal [1]. Here we report transport and spectroscopic studies on the metal-insulator transition (MIT) induced by the modulations of effective electron correlation and magnetic structures, which is finely tuned by external pressure, chemical substitutions ($R = Nd_{1-x}Pr_x$ and Sm_yNd_{1-y}), and magnetic field. A reentrant insulator-metal-insulator transition is observed near the paramagnetic insulator-metal phase boundary reminiscent of a first-order Mott transition for $R = Sm_yNd_{1-y}$ compounds (y˜0.8). The metallic states on the magnetic domain walls (DWs), which are observed for $R =$ Nd in real space [2] as well as in transport properties [3], is simultaneously turned into the insulating one. These findings imply that the DW electronic state is intimately linked to the bulk states. For the mixed $R = Nd_{1-x}Pr_x$ compounds, the divergent behavior of resistivity with antiferromagnetic order is significantly suppressed by applying a magnetic field along [001] direction [4]. It is attributed to the phase transition from the antiferromagnetic insulating state to the novel Weyl (semi-)metal state accompanied by the change of magnetic structure. The present study combined with experiment and theory suggests that there are abundant exotic phases with physical parameters such as electron correlation and Ir-5d magnetic order pattern. Work performed in collaboration with J. Fujioka, B.-J. Yang, C. Terakura, N. Nagaosa, Y. Tokura (University of Tokyo, RIKEN CEMS), J. Shiogai, A. Tsukazaki, S. Nakamura, S. Awaji (Tohoku University). [1]This work was supported by JSPS FIRST Program and Grant-in-Aid for Scientific Research (Grants No. 80609488 and No. 24224009).

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