Electronic Properties of Polar-Metallic Iridium Oxides

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Typical materials where the inversion symmetry of the crystal structure is broken are ferroelectrics, which are of course insulators. Besides them, there are conducting materials with broken inversion symmetry. Such materials are called as "polar metals," and the emergence of exotic transport properties is theoretically predicted; the electronic transport is affected by spin-orbit interaction which results in, for example, the inverse Faraday effect.[1] Some members of pyrochlore oxides like $Cd_2Re_2O_7$ and $Pb_2Ru_2O_7$ have a polar-metallic nature at low temperature ($Cd_2Re_2O_7$) or room temperature ($Pb_2Ru_2O_7$).
$5d$ electrons of transition metals show strong spin-orbit coupling. For example, the reconstruction of Ir $5d$ t_{2g} electron band due to spin-orbit coupling have been observed in the optical spectra of $Sr_{n+1}Ir_nO_{3n+1}$.[2] In this study we report on the electronic properties of a pyrochlore oxide $Pb_2Ir_2O_7$ which has $5d$ conduction electrons on the inversion-broken lattice at room temperature. The optical spectrum suggests that spin-orbit coupling contributes to the band formation. Moreover, the second harmonic generation shows a large inversion symmetry breaking effect in $5d$ electron bands. These results indicate a possibility of novel properties in $Pb_2Ir_2O_7$.

[1]V.M. Edelstein, Phys. Rev. Lett. **80**, 5766 (1998).
[2]S.J. Moon *et al.*, Phys. Rev. Lett. **101**, 226402 (2008).