Doping Sr_2IrO_4 with 4d transition-metal (Rh, Ru) : the role of oxygen

V. Brouet[1], P. Foulquier[1], A. Louat[1], D. Colson[2], P. Le Fèvre[3], F. Bertran[3]
[1]*Laboratoire de Physique des Solides, CNRS, Univ. Paris-Sud, Université Paris-Saclay, 91405 Orsay Cedex, France*
[2]*Service de Physique de l'Etat Condensé, Orme des Merisiers, CEA Saclay, CNRS-URA 2464, 91191 Gif sur Yvette Cedex, France*
[3] *Synchrotron SOLEIL, 91192 Gif sur Yvette, France*

Email: veronique.brouet@u-psud.fr

Sr_2IrO_4 is a layered perovskite, structurally very similar to cuprates. One difference is that iridium is a *5d* transition metal, for which much smaller electronic correlations are *a priori* expected. Nevertheless, Sr_2IrO_4 is an insulator, despite having an odd number of electrons in *5d* band, and orders antiferromagnetically below 240 K. This is believed to be the consequence of the large spin-orbit coupling, characteristic of this heavy element. It reshapes the electronic structure to form a non-degenerate half-filled band at the Fermi level, which is much more sensitive to electronic correlations than the original electronic structure. This new electronic structure also becomes very analogous to that of cuprates, so that theoreticians have proposed that doped compounds could be superconducting. Although no bulk systems have been found superconducting up to now, signs of superconductivity may have been observed in surface doped systems of Sr_2IrO_4.

We have grown a series of Rh and Ru doped samples of Sr_2IrO_4 and characterize the metallic states emerging from these substitutions with ARPES. Unexpectedly, Rh, which is isovalent to Ir traps an electron and produces an effective hole doping of the Ir sites. The evolution of the electronic structure can be described as a rigid shift of the Fermi level in the lower Hubbard band, producing a very incoherent metallic state. On the other hand, Ru, which brings one hole compared to Ir, does not produced a hole-like rigid shift. Instead, new bands appear at the Fermi level for a high Ru content, which form a metallic state characterized by a strongly reduced spin-orbit coupling. We rationalize these contrasting behaviors by different hybridization processes between oxygen and the 3 transition metals [1]. This reveals in turn a hidden but major role of oxygen in iridates.

References

[1] V. Brouet *et al.*, Phys. Rev. B **104**, L121104 (2021)