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High-pressure electrical-transport behaviour in charge-ordered Fe₂OBO₃ and LuFe₂O₄

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Abstract content
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Fe₂OBO₃ and LuFe₂O₄ are Fe-based 3d compounds known to be mixed-valence (Fe²⁺ and Fe³⁺) insulators at ambient conditions. These are relatively new charge ordering (CO) compounds that evidence strong magneto-electric coupling, besides offering the best potential for establishing the CO mechanism. Fe₂OBO₃ has monoclinic and orthorhombic crystal structures at ambient conditions and high pressure (HP) respectively. The compound orders ferrimagnetically at T_M ˜ 155K and has a CO temperature T_{CO} ˜ 320K. Whereas, LuFe₂O₄ has T_M and T_{CO} as 240K and 330K, respectively. At HP, these are anticipated to show new ground states (i.e., CO collapse, valence fluctuations or new CO states). For instance, in recent work on Fe₂OBO₃, a CO instability occurs at P ˜16 GPa [1]. In LuFe₂O₄, a pressure-induced structural transition (rhombohedral to orthorhombic) occurs in the range 5 – 10 GPa with indications of a new CO state occurring in the fully transformed sample at P > 8 GPa [2]. Our interest is to explore in further detail the magneto-electronic ground-states of the HP phases of these two topical CO compounds, e.g., to check whether an insulator-metal transition ensues. This would provide crucial complementary information to our Fe Mössbauer-magnetic and XRD-structural probes of the new HP stabilized electronic phases.
The pressure response of electrical transport properties of polycrystalline powdered Fe₂OBO₃ and LuFe₂O₄ samples have been investigated by way of resistivity measurements at variable cryogenic temperatures from ambient pressure up to ˜20 GPa in a diamond anvil cell. The DC four-probe resistivity was determined using the Van der Pauw method. At low pressure (LP) both samples display semiconducting behaviour, anticipated in the CO state which is prevalent below ambient temperatures. We are able to monitor the band-gap evolution of the LP (CO stabilized) phase. We will present our results on how the systems evolve towards their new electronic HP phases, as well as provide information on the nature of the carrier transport.

[1] G.R. Hearne et al., PRB 86, 195134 (2012).
[2] J. Rouquette et al., PRL 105, 237203 (2010).

Apply to be
 considered for a student
   award (Yes / No)?

Yes

Level for award
 (Hons, MSc,
   PhD)?

PhD

Main supervisor (name and email)
and his / her institution

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Would you like to
 submit a short paper
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Yes

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