Pressure-Induced Helium Trapping in Sr_2FeIrO_6 Double Perovskite

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Abstract

Double perovskites containing transition-metal ions with strong electronic correlations and spin–orbit coupling provide an excellent platform to explore the coupling between crystal structure, lattice compressibility, and local electronic environments under extreme conditions. In this work, we report pressure-induced helium trapping in the double perovskite Sr_2FeIrO_6,[1] investigated using high-pressure synchrotron X-ray diffraction with helium as pressure-transmitting medium.

Our results show that, upon compression, helium atoms are incorporated into the Sr_2FeIrO_6 structure, producing a clear modification of its pressure–volume response. The trapped helium reduces the effective compressibility of the material and alters the equation of state with respect to the behaviour expected for a purely compressed framework. This demonstrates that helium, often considered an inert hydrostatic medium, can actively interact with host structures under pressure. The combined experimental and theoretical results therefore provide a consistent picture of pressure-induced helium uptake and its direct influence on the mechanical response of the material.

This study highlights the importance of considering pressure-transmitting media as active chemical agents in high-pressure experiments. The observation of helium trapping in Sr_2FeIrO_6 opens new perspectives for tuning the structural and electronic properties of complex oxides through the controlled incorporation of noble gases under compression.

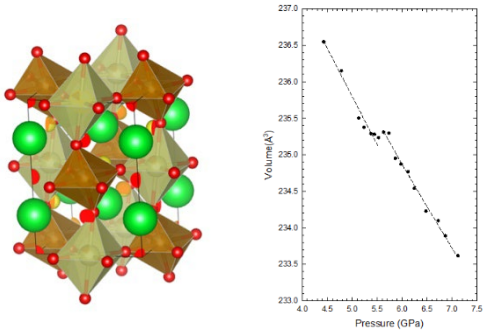

Figure1. (left) Scheme of the Sr_2FeIrO_6 with helium inclusions. (right) P-V Equation of state of SFIO with helium.

1. S. Gallego-Parra et al. *Unveiling the ambient-condition structure of Sr2FeIrO6: a triclinic phase through synchrotron-based X-ray techniques and high pressure*. IUCrJ 12, 683 (2025)