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A Structural Study of B-Cation Substituted Lanthanum Rhodates

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The perovskites of the chemical form La_2MRhO_6 (where M = Mg, Sc, Cr, Mn, Fe, Co, Ni, Cu, Zn and Ga) are of interest due to their potential ferromagnetic or antiferromagnetic properties. Rhodium containing perovskites are poorly studied since rhodium's most common oxidation state, Rh^{3+}, has d^6 electrons and is diamagnetic, meaning such materials do not feature interesting magnetic properties. However, rhodium itself is widely used in the catalyst industry.
This work aims to synthesise and characterise compounds containing both Rh^{3+} and Rh^{4+} adopting the perovskite crystal structure. Determining the oxidation state of the substituting metallic cation on the B-site of lanthanum rhodate is a challenge, since some of the dopant metals have multiple oxidation states. Also, substituting another ion in place of rhodium on the same crystallographic site raises the question of the possible ordering of the B-cations. This can lead to either spin-ordered compounds that can give rise to interesting magnetic properties, or spin-glasses that can produce high magnetically frustrated materials.
Polycrystalline samples of substituted lanthanum rhodates were made with the abovementioned chemical compositions. A few single crystals of these lanthanum rhodates were also grown. A combination of conventional, synchrotron x-ray and neutron diffraction methods was used to determine the structure of these compounds, together with energy dispersive spectroscopy via the scanning electron microscope. The oxidation states of the substituting cations were determined indirectly from the structural parameters. Neutron diffraction was used to analyse the La_2NiRhO_6 and La_2FeRhO_6 compounds and using low temperature neutron diffraction, no magnetic ordering was observed for La_2FeRhO_6 down to 16 K. The questions regarding the ordering of the B-cations were also addressed.