Structural, Magnetic and Transport Properties of a New Class of Ferromagnetic Semiconductors/Metals: \((\text{Ba, Sr})M_{2+x}\text{Ru}_{4-x}\text{O}_{11}\) (\(M = \text{Fe, Co}\))

LARYSA SHLYK, LANCE DE LONG, SERGIY KRYUKOV, Dept. of Physics and Astronomy, University of Kentucky, BARBARA SCHÜPP-NIEWA, RAINER NIEWA, Department Chemic, Technische Universität München — Single crystals (mm size) of \((\text{Ba, Sr})\text{Fe}_{2+x}\text{Ru}_{4-x}\text{O}_{11}\) and \((\text{Ba, Sr})\text{Co}_{2+x}\text{Ru}_{4-x}\text{O}_{11}\) were grown for the first time. X-ray refinements confirmed a hexagonal space group \((\text{P}6_3/\text{mmc}, \text{No. 194})\) with two crystallographic sites having mixed Ru and Fe/Co occupation, and one site occupied exclusively by the 3d species. Structural parameters and charge balance suggest oxidation states \(\text{Co}^{2+}\) and mixed \(\text{Ru}^{3+}/\text{Ru}^{5+}\) in the Co compound, and mixed \(\text{Fe}^{2+}/\text{Fe}^{3+}\) and \(\text{Ru}^{3+}/\text{Ru}^{5+}\) in the Fe compound. The physical properties of these single crystals are sensitive to site disorder among the transition metal ions. Magnetic and transport measurements show the Co-bearing barium ferrite is a ferromagnetic metal below 105 K. In contrast, Fe-bearing barium and strontium compounds exhibit long-range ferromagnetic order at temperatures above 400 K, and narrow-gap semiconducting properties that include a large anomalous Hall conductance, low resistivity, and high carrier concentration. These characteristics make the Fe-bearing materials promising new candidates for spintronic applications.

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