Electron holography and magnetic properties of exsolved synthetic titanomagnetites

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Natural titanomagnetites frequently exhibit nano-scale exsolution structures, but the contribution to bulk magnetic properties of these assemblages of iron-rich ferromagnetic titanomagnetites and titanium-rich paramagnetic ilmenite and ulvospinel is poorly understood. To investigate the role of these two-phase systems, a suite of single-phase polycrystalline and single-crystal samples were synthesized from the magnetite-ulvospinel solid solution. They were characterized using magnetic properties and subsequently resintered under oxidizing conditions to create two-phase systems of titanomagnetite and ilmenite. These systems exhibited a variety of geometries depending on the oxygen fugacity and temperature of the oxidizing run, including lamellar exsolution which mimics that found in natural magnetite-ulvospinel assemblages. These exsolved samples were examined using electron holography to quantitatively measure the magnetic flux in and around the magnetic grains and the collective behavior of interacting magnetic grains. A more thorough understanding of these interaction effects and the domain states of the magnetic grains can inform our interpretation of both remanence measurements and bulk rock properties.