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Unusual magnetic ordered metallic state in $EuNiO_3$ under pressure

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According to the magnetic phase diagram of the RNiO3 series at ambient pressure, the ground state changes from an antiferromagnetic insulating to a nonmagnetic metallic state (R = La). As the distortion is larger in for small R3+ ions, the tolerance factor, which reflects the degree of distortion of perovskites, increases as the radius R3+ increases. Since the tolerance factor increases with increasing pressure, pressure tuning of the stoichiometric RNiO3 compound is a powerful technique for understanding phase transitions. However, only few RNiO3 compounds have been investigated up to very high pressure, in particular the pressure dependence of TN in them.
We have studied the pressure effect on the structural and magnetic properties of EuNiO3 up to ~20 GPa using low-temperature synchrotron angle-resolved x-ray diffraction and 151Eu nuclear forward scattering of synchrotron radiation, respectively. With increasing pressure, we find that after a small increase of TN (< 2 GPa) and the induced magnetic hyperfine field Bhf at the 151Eu nucleus (< 9.7 GPa), both TN and Bhf are strongly reduced and finally disappear at pc~10.5 GPa. The analysis of the structural parameters up to 20 GPa reveals no change of the lattice symmetry within the experimental resolution. Meanwhile, the a-lattice parameter almost saturates at ~10.5 GPa. The 151Eu nuclear forward scattering results reveal that with increasing pressure both Bhf and TN disappear at pc. Keeping in mind that EuNiO3 displays the pressure-induced IM transition at pIM~6 GPa, this result implies that under pressure the ground state of EuNiO3 changes from antiferromagnetic insulator to antiferromagnetic metal at pIM and then to a nonmagnetic metal above pc. We assumed two magnetically nonequivalent Eu sites with the ratio of 1:1 to analyze the observed 151Eu nuclear forward scattering spectra in the magnetic ordered state, manifesting that the charge disproportionation of Ni ions exits in the pressure-driven antiferromagnetic metal phase.

Keywords: EuNiO3, Nuclear forward scattering, high pressure