Metal-insulator transition and large negative magnetoresistance in $Ba_{3-x}Eu_xNb_5O_{15}$

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$Ba_3Nb_5O_{15}$ has a tetragonal tungsten bronze structure with 0.2 electrons per Nb in the 4*d* orbital, which is responsible for its metallic conduction. It is known that it becomes insulating by substituting Sr for Ba [1-3], though the nominal number of electrons per Nb remains the same. We grew single crystals of the series of compounds in which Ba is substituted by various rare earths *R*. We found that *R* = Eu becomes divalent and its substitution for Ba results in the metal-insulator transition, similarly to the Sr substitution. We also found that $Ba_{3-x}Eu_xNb_5O_{15}$ exhibits a large negative magnetoresistance, probably caused by the coupling between the conduction electrons in Nb 4*d* orbitals and the 4*f* spins in the Eu ions, and its magnitude $\rho(0)/\rho(H)$ is enhanced and amounts to $\sim 5 \times 10^3$ near the metal-insulator phase boundary [4]. We also measured the Hall coefficient, Seebeck coefficient, and optical conductivity of these compounds, and found a substantial decrease in the number of conduction electrons as approaching the metal-insulator phase boundary, which may be responsible for the enhancement of negative magnetoresistance.

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