S4.4 Transition from Mott Insulator to Superconductor in metal-cluster compounds $Ga(Ta,Nb)_4(Se)_8$

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We have investigated the effect of pressure on the electronic, structural and dynamical properties of semiconducting chalcogenides GaNb4Se8 and GaTa4Se8 which crystallize in the fcc $GaMo_6S_4$-type structure using electrical resistance, x-ray diffraction and Raman spectroscopy, respectively. The interesting aspect to study these compounds is that the conduction occurs through hopping of the charge carriers between well separated (> 4 Å) tetrahedral $(Ta,Nb)_4$-metal clusters which leads to strong correlation effects between localized electronic states. Under high pressure, we find in both compounds a metallic conductivity and a pressure-induced superconductivity at a critical pressure (pc): for $GaNb_4Se_8$ (T_c = 4 K at p_c = 13 GPa) and $GaTa_4Se_8$ (T_c = 5.8 K at p_c = 11.5 GPa). High pressure single crystal x-ray diffraction and Raman measurements on GaTa4Se8 show that the onset of superconductivity is connected with a strong reduction of the octahedral distortion and a simultaneous softening of the phonon associated with Ta-Se bond which exhibits a finite value above p_c.