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 GaNb$_4$Se$_8$ and GaTa$_4$Se$_8$ which crystallize in the fcc GaMo$_6$S$_4$-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 ($p_c$): for GaNb$_4$Se$_8$ ($T_c = 4$ K at $p_c = 13$ GPa) and GaTa$_4$Se$_8$ ($T_c = 5.8$ K at $p_c = 11.5$ GPa). High pressure single crystal x-ray diffraction and Raman measurements on GaTa$_4$Se$_8$ 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 $p_c$. 