
Crystal Growth, Raman Scattering and Optical Properties of the Superconductor Cd$_2$Re$_2$O$_7$ ($^{16}$O, $^{18}$O)

Using the Physical Vapor Transport method, single crystals of Cd$_2$Re$_2$O$_7$ have been grown, and crystals of dimensions up to 8x6x2 mm have been achieved.

Using Factor Group Analysis on three different structures of Cd$_2$Re$_2$O$_7$, the number of IR and Raman active phonon modes close to the Brillouin zone centre have been determined and the results have been compared to the temperature-dependence of the Raman shifts of $^{16}$O and $^{18}$O samples. After scaling (via removing Bose-Einstein and Rayleigh scattering factors from the scattered light) all spectra, each spectrum was fitted with a number of Lorentzian peaks. The temperature-dependence of the FWHM and Raman shift of mode E$_g$, shows the effects of the two structural phase transitions above T$_c$.

By means of Kramers-Kronig analysis, the absolute reflectance was used to calculate the optical conductivity and dielectric function. The real part of optical conductivity shows five distinct active phonon modes at 44, 200, 300, 375 and 575 cm$^{-1}$ at all temperatures including a Drude-like behaviour at low frequencies. The imaginary part of the calculated dielectric function indicates a mode softening of the mode 44 cm$^{-1}$ below T$_c$. 