Investigation of the bosonic spectral density in highly under-doped YBa$_2$Cu$_3$O$_{6.35}$

JING YANG, THOMAS TIMUSK, Department of Physics and Astronomy, McMaster University, DOUGLAS BONN, RUIXING LIANG, WALTER HARDY, Department of Physics and Astronomy, University of British Columbia — We studied the doping dependence of the bosonic spectral function in nearly optimally-doped La$_{2-x}$Sr$_x$CuO$_4$, ortho-II YBa$_2$Cu$_3$O$_{6.35}$ and highly under-doped YBa$_2$Cu$_3$O$_{6.35}$ single crystals by optical spectroscopy. With fixed oxygen content, the hole doping of the YBCO system can be fine-tuned by varying the degree of oxygen ordering. After annealing and quenching, we were able to make oxygen less ordered and obtain a highly under-doped YBa$_2$Cu$_3$O$_{6.35}$ sample with a very low transition temperature around 18K (about 20% of the optimal T$_c$). The a-axis reflectance data of this sample at nine temperatures between 30K and 295K were measured with an infrared spectrometer between 60 and 40 000 cm$^{-1}$ with the aid of three different infrared and optical polarizers. The optical properties of the highly under-doped YBCO sample show dramatic changes compared to the ortho-II YBCO sample. The strong sharp mode in the bosonic spectral function $\alpha^2 F(\Omega)$ in the ortho-II YBCO is absent in the highly under-doped sample.