Overdoped YBaCuO thin films in THz frequency range

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$Y_{1-x}Ca_xB_2Cu_3O_{7-\delta}$ thin films were investigated using frequency domain THz spectroscopy by a sub-millimeter spectrometer in the Mach-Zehnder arrangement. For this purpose, 5% and 10% Ca concentration and films thickness of $500-600$ Å were used. The films were deposited by off-axis DC sputtering on $LaAlO_3$ substrates. The films reveal a clear c-axis orientation, $T_c = 85K$ and $77K$ for 5% Ca and 10% Ca respectively. Both thin film batches show a decrease of plasma frequency as temperature increases and superconducting transition is approached. The quasiparticles scattering rate decreases in the normal state and undergo an abrupt decrease as T_c is approached. The imaginary part of the conductivity was obtained to be proportional to ω^{-1}. The real part of conductivity showed a well known frequency and temperature dependence, where it increases below T_c and obtains a maxima at about 50 K. However, a sharp decrease of the real part of the conductivity was observed at about $10cm^{-1}$. This decrease happens below T_c and gets dominant as temperature decreases. Moreover, this sharp decrease in $\sigma_1(\omega)$ at $10cm^{-1}$ was not observed in optimally doped $YBCO$ samples. At these frequencies the gap values are much smaller than those obtained by Microwave and Tunneling measurements, arguing for a change in the superconducting order parameter in the overdoped regime. The difference between these mentioned observations will be discussed.