Charge Carrier Dynamics in the Vicinity of the Bandwidth-Controlled Mott-Hubbard Transition in κ-(BEDT-TTF)$_2X$

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Physics close to the Mott transition is one of the central issues in strongly correlated electron systems. Interactions between charge and spin degrees of freedom result in rich phase diagrams including insulating, antiferromagnetic, exotic metallic and superconducting phases. The quasi 2D organic charge-transfer salts κ-(BEDT-TTF)$_2X$ are model compounds for these phenomena. Here, we present a comprehensive study of the charge dynamics at the border between Mott insulating and Fermi liquid states which gives insights into the influence of electronic correlations on the properties itinerant and localized charge carriers. The Mott transition from the "insulating" to the "metallic" part of the phase diagram is achieved by changing the spacing between the molecules, i.e., by changing the bandwidth. We controlled the bandwidth by a systematic variation of the Br content in the anions $X = \mathrm{Cu[N(CN)_2]Br}_x\mathrm{Cl}_{1-x}$.

We will compare experimental results obtained by polarized infrared spectroscopy as a function of temperature, frequency and Br-substitution with DMFT calculations and discuss how Drude spectral weight, scattering rate and effective mass enhancement develop in the vicinity of the the Mott-Hubbard transition. In the metallic state (small U), coherent response of correlated charge carriers is observed below 50 K. Together with the frequency dependence of the scattering rate and effective mass, this observation is in agreement with DMFT calculations for a Hubbard model on a frustrated lattice. We observe a reduction of the spectral weight of the Drude-peak on increasing U and its disappearance upon crossing the phase border to the Mott insulating state.