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Probing pressure-driven phase transitions using THz time domain spectroscopy

We describe recent progress in developing a setup in which we use a diamond anvil cell (DAC) to explore phase transitions under high pressure and ultrafast photoexcitation in combination with terahertz time-domain spectroscopy (THz TDS). We aim to access pressures of up to 10 GPa at temperatures as low as 10 K.

We will present our investigation of the Mott insulator (V(1-x)Cr(x))(2)O(3). This compound exhibits a pressure-driven insulator-to-metal transition and a temperature-dependent transition to an antiferromagnetic insulator phase. We present recent measurements on samples with 5% and 10% Cr doping, crossing the insulator-to-metal transitions at room temperature and pressures of 1.7 GPa and 2.7 GPa respectively and crossing the transition to the antiferromagnetic insulator phase at 140 K and 3.5 GPa (10% doping). These transitions have previously not been studied using THz TDS and demonstrate our capability to control both pressure and temperature separately.

As the sample chamber in a DAC is only a few hundred microns wide and thick, pressure dependent studies are limited to small samples, which poses a challenge to THz spectroscopy measurements:
(i) Given that the size of the focused THz spot is also on the order of a few hundred microns, the external part of the THz beam is necessarily cut off. Careful referencing between measurements is therefore required, and a larger THz bandwidth is preferred as the size of the THz focal spot is thereby reduced. (ii) Reflections of the THz beam inside the sample lead to features that overlap with the main pulse in the time domain, hindering a simple Fourier transform analysis. We will present the technical and analytical approaches we are exploring to address these two issues.

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