Complex Conductivity of UTX Compounds in High Magnetic Fields

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Introduction

Isostructural UTX compounds (T = transition metal, and X = p-electron element) have been the subject of intense studies in the past decades because of the specific nature of U 5f-electron magnetism. The f electrons of U are found to be intermediate between the delocalized d electrons of the transition metal and the well-localized 4f electrons of the lanthanide. Two mechanisms are known to lead to delocalization the 5f electrons, the direct 5f-5f overlap and the 5f-ligand hybridization [1]. The 5f-ligand hybridization can be varied in a wide range by changing all the available T and X ligands. Depending on the degree of the 5f-ligand hybridization, large variety of magnetic phenomena ranging from weak paramagnetism to various types of long-range magnetic ordering has been observed in UTX compounds. Here, we present measurements of the RF skin depth of UTX (T = Ni, and X = Al, Ga, Ge) in magnetic field up to 50T. Taking all the anomalies in the RF skin depth measurements, a tentative B-T phase diagrams can be constructed

Experimental

Our experiments were performed on high purity single crystals. The experiments were performed using the 60 T short pulse magnet at the Pulse Field Facility, NHMFL, Los Alamos National Laboratory. The RF penetration depth was measured by coupling the sample to the inductive element of a resonant tank circuit. Shifts in the resonant frequency (Δf) of the circuit are found to be proportional to the skin depth and therefore the resistivity of the sample.

Results and Discussion

Fig. 1 shows the frequency shift (Δf) in the tank circuit as a function of applied magnetic fields for different UTX compounds. For UNiAl (see Fig.1a), at 1.5K, we observed a metamagnetic transition at $B_c = 11.6T$ when the field is applied along the c-axis. $B_c$ is shifted to lower fields with increasing temperatures in good agreement with previous magnetoresistance (MR) data [2]. This indicates a direct correspondence between the features in Δf and MR. For UNiGa, at 4 K, two metamagnetic transitions were observed at 0.4T and 0.8T when the field is applied along the c-axis, while only one metamagnetic transition occurs at 15.9T when the field is applied perpendicular to the c-axis (see Fig. 1b and Fig. 1c). For UNiGe (see Fig.1d), at 4K, we observed three metamagnetic transitions at 19.5T, 24T and 28T when the field is applied along the b-axis. The first two transitions were observed in the previous MR data [3], while there is no report on the third one.

References