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THE FAR INFRARED OPTICAL REFLECTIVITY OF U_2PtC_2

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Abstract: We measure the optical reflectivity of U_2PtC_2 over the whole energy range between 1 meV and 12 eV, at two temperatures (6 K and 300 K). At room temperature we observe free carrier behaviour at the lower frequencies up to about 0.1 eV. A value of the plasma frequency can be estimated of 2 eV. Three broad peaks can be observed, respectively at 0.45, 2 and 6 eV. At low temperature and low frequency, in similarity with UPt_3 and $CeCu_6$, a minimum appears in the optical conductivity at 4 meV, indicating a renormalized plasma frequency. At energies slightly larger a structure is observable which shows a shoulder at about 10 meV. It is interesting to observe that the spectrum shows the same characteristics than other heavy fermion, even if the energy scale is different.

INTRODUCTION

In the last years we measure the far infrared reflectivity of several intermediate valence and heavy fermion compounds[1]. In these compounds the strong interaction between the *f* electrons of an actinide or rare earth ion and the conduction electrons yields to narrow hybridized bands at low temperatures. This implies an enhancement of the effective masses and of the specific heat and a loss of the localized magnetic moments. The low photon energy and the high resolution typical of optical measurements permit to investigate directly the excitations of the electronic ground state. In heavy fermion systems at low temperatures we always observe a minimum in the optical conductivity at energies of the order of 1 meV. U_2PtC_2 has been included in the class of heavy fermion materials[2]. Specific heat shows a coefficient $\gamma = 75$ mJ/mol U atom K^2. This material is therefore located in an intermediate position between the known U based heavy fermions such as UPt_3 or UBe_{13}, and the "normal" compounds such as U_6Fe.

EXPERIMENT AND DISCUSSION

We measure the optical reflectivity of a monocrystal of U_2PtC_2 grown by G.P.Meisner in Los Alamos, showing a good surface of about 1 x 2 mm^2. The measurements at room temperature cover the whole spectral range from 1 meV up to 12 eV. In the far infrared, below 100 meV, we measured also the reflectivity at the temperature of 6 K. At the low frequencies a relatively big difference can be observed between the two spectra.

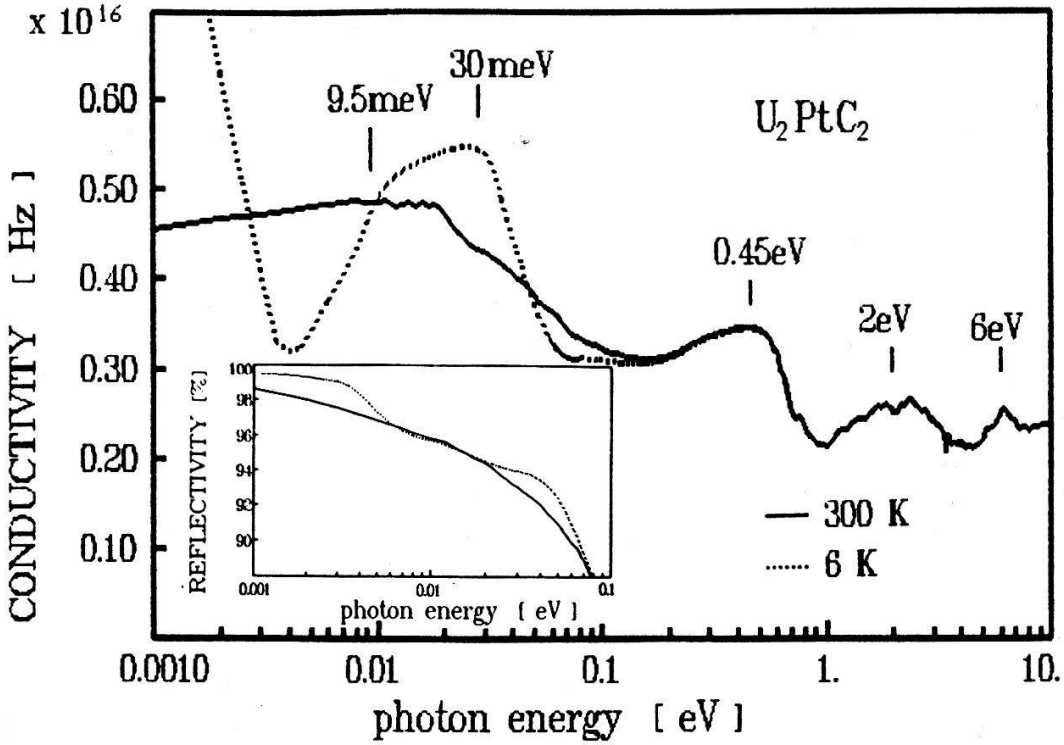

Fig.1 - Optical conductivity and (insert) reflectivity of U_2PtC_2.

The optical conductivity of U_2PtC_2 at 6 K obtained by Kramers–Kronig transformation (Fig. 1) shows a minimum at 4 meV. Between 4 meV and 70 meV a smoothed structure is placed. Two different plasma frequencies can be found. One is the normal plasma frequency, $\omega_p = 2$ eV. At low temperature a second small plasma frequency can be deduced by our results $\omega_p^* = 0.44$ eV. It is reduced by i) the increase of the effective mass when the f electrons hybridize with the conduction band ($(\omega_p/\omega_p^*)^2 \sim m^*/m_c \sim 20$; $m^* = 52$ m in one band approximation (250 in UPt_3[1])) and ii) the strong screening effect due to the many body interaction. The low energy structure seems obtained by the convolution of two different structures at 9.5 and 30 meV. The oscillator strength of the structure at 9.5 meV is $\rho = 0.021$ and corresponds to a transition between two hybridized f bands.

It is interesting to observe that, apart from the different enhancement of the low energy peak and the energy scale which is about 3 times larger than in UPt_3, the general features of the spectrum of U_2PtC_2 recall the results of the other heavy fermion systems. In particular we found evidence also in this material that hybridization yields at low temperature to an observable two band structure in the vicinity of the Fermi level.

REFERENCES

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