UNDERSTANDING THE TOTALLY SYMMETRIC INTRAMOLECULAR VIBRATIONS IN κ-PHASE ORGANIC SUPERCONDUCTORS

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Introduction

We report magneto-infrared measurements of three quasi-isostructural κ-phase organic molecular solids: κ-$(ET)_2Cu(N(CN)_2)Br$, κ-$(ET)_2Cu(SCN)_2$, and κ-$(ET)_2Cu(N(CN)_2)Cl$. Our results support the contributing role of electron-molecular vibrational coupling in the pairing mechanism of layered organic superconductors, and we identify the most important totally symmetric modes in κ-$(ET)_2Cu(N(CN)_2)Br$ within the non-planar molecular building block picture.

Experimental

Magneto-infrared experiments were carried out at 4.2 K. The applied field was used to tune between the superconducting state and the normal state. Superconductivity in κ-$(ET)_2Cu(N(CN)_2)Br$ is quenched above 6.2 T.

Results and Discussion

Several totally symmetric intramolecular modes of κ-$(ET)_2Cu(N(CN)_2)Br$ change systematically with applied magnetic field and are sensitive to the superconducting to normal state transition at H_{c2}. The most important mode involves the C=C stretching and is centered near 1250 cm^{-1}. Within the non-planar molecular building block picture, we assign this mode as ν_4. The ν_{10} (ring breathing) and ν_{13} modes also change systematically with applied field. Figure 1 shows a comparison of the reflectance ratio for κ-$(ET)_2Cu(N(CN)_2)Br$ with similar results on the aforementioned quasi-isostructural analogs. The magneto-infrared features in κ-$(ET)_2Cu(N(CN)_2)Br$ (T_c =11.6 K) are similar but noticeably larger than those in κ-$(ET)_2Cu(SCN)_2$ (T_c =10.4 K), a result that may be correlated with the higher value of T_c. Interestingly, no field-induced features were observed within our sensitivity for the non-superconducting Cl compound. These results support the contributing role of electron-molecular vibrational coupling in the pairing mechanism of layered organic superconductors.

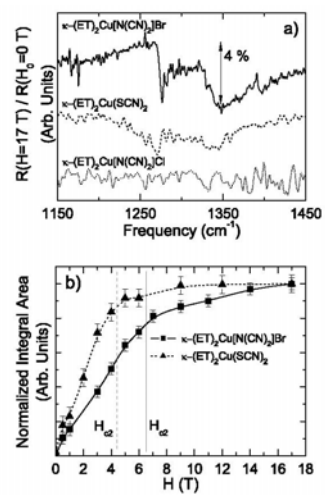

Figure 1: (a) Reflectance ratio, R(H = 17 T)/R(H = 0 T), of the totally symmetric C=C stretching mode for κ-$(ET)_2Cu(N(CN)_2)Br$, κ-$(ET)_2Cu(SCN)_2$, and κ-$(ET)_2Cu(N(CN)_2)Cl$ at 4.2 K. The double arrow shows the size of the field-induced features. The reflectance ratio curves have been off-set for clarity. (b) Normalized integral area of ν_4 reflectance ratio changes vs. applied magnetic field for the two superconducting materials. Solid and dashed vertical lines indicate H_{c2} values for κ-$(ET)_2Cu(N(CN)_2)Br$ and κ-$(ET)_2Cu(SCN)_2$, respectively. Lines connecting the data points guide the eye.

Conclusions

Our results support the contributing role of electron-molecular vibrational coupling in the pairing mechanism of layered organic superconductors, and we identify the most important totally symmetric modes in κ-$(ET)_2Cu(N(CN)_2)Br$ within the non-planar molecular building block picture.

Acknowledgements

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