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Summary

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FAR INFRARED OPTICAL PROPERTIES OF $NbSe_3$

W.A. Challener and P.L. Richards

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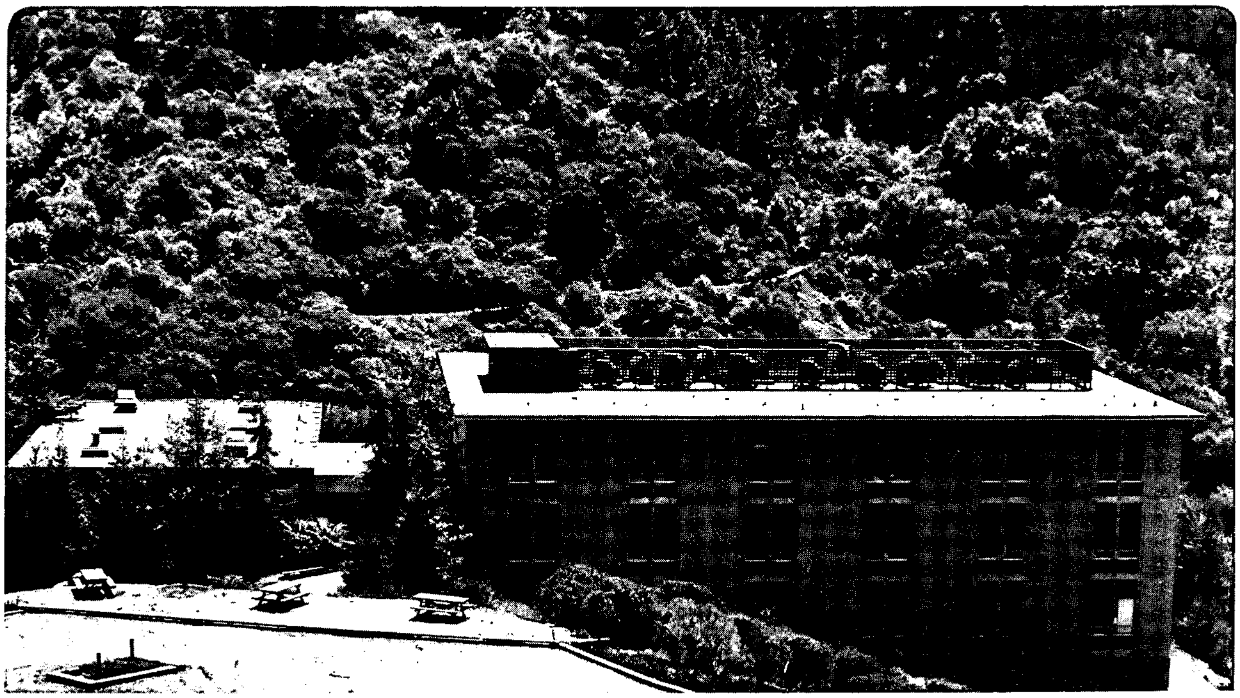

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(Summary)

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FAR INFRARED OPTICAL PROPERTIES OF $NbSe_3$

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$NbSe_3$ is a prototype for sliding charge density wave (CDW) systems. It undergoes independent and incommensurate CDW phase transitions at T_1 = 145 K, and T_2 = 59 K. At each transition a fraction of the free carriers present at room temperature condense into a CDW. The oscillator strength of the condensed carriers can appear in a low frequency pinned mode [1], a single-particle continuum above a CDW energy gap [2], and coupled CDW carrier-optical phonon modes (phase phonons) [3].

We have measured the far infrared reflectance of $NbSe_3$ and have used a Kramers-Kronig analysis to obtain the estimate of the frequency dependence of the conductivity, $\sigma_1(\omega)$ shown in Fig. 1(a). The qualitative features of the conductivity include many phonons which appear below T_2, and a low frequency contribution from the free carriers and the pinned mode.

General arguments show that at 2 K a charge density (CDW) energy gap exists between 120 and 190 cm^{-1}, the relaxation time(s) of the free carriers and CDW pinned mode is $>3\times10^{-12}$ s, and the ratio of the free carrier concentration to band mass is $<2\times10^{20}$ cm^{-3}/m_0.

A detailed model fit to the conductivity shown in Fig. 1(b) reproduces the data very accurately. It gives estimates of carrier concentrations and relaxation times, electron-phonon coupling constants and the size of the CDW energy gap. When analyzing a limited data set from a very complicated physical system like $NbSe_3$, however, one cannot be entirely certain that all of the relevant physics is included in the model. As our knowledge about $NbSe_3$ increases, the fitting procedures used here may have to be modified. It seems clear, however, that the far infrared reflectance data will provide strong constraints to any proposed model.

We particularly wish to thank P. Monceau, who provided the $NbSe_3$ used for these measurements, and L.M. Falicov, P.A. Lee, N.P. Ong, A.M. Portis, and T. Rasing for useful discussions. This work was supported by the Director, Office of Energy Research, Office of Basic Energy Sciences, Materials Sciences Division of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

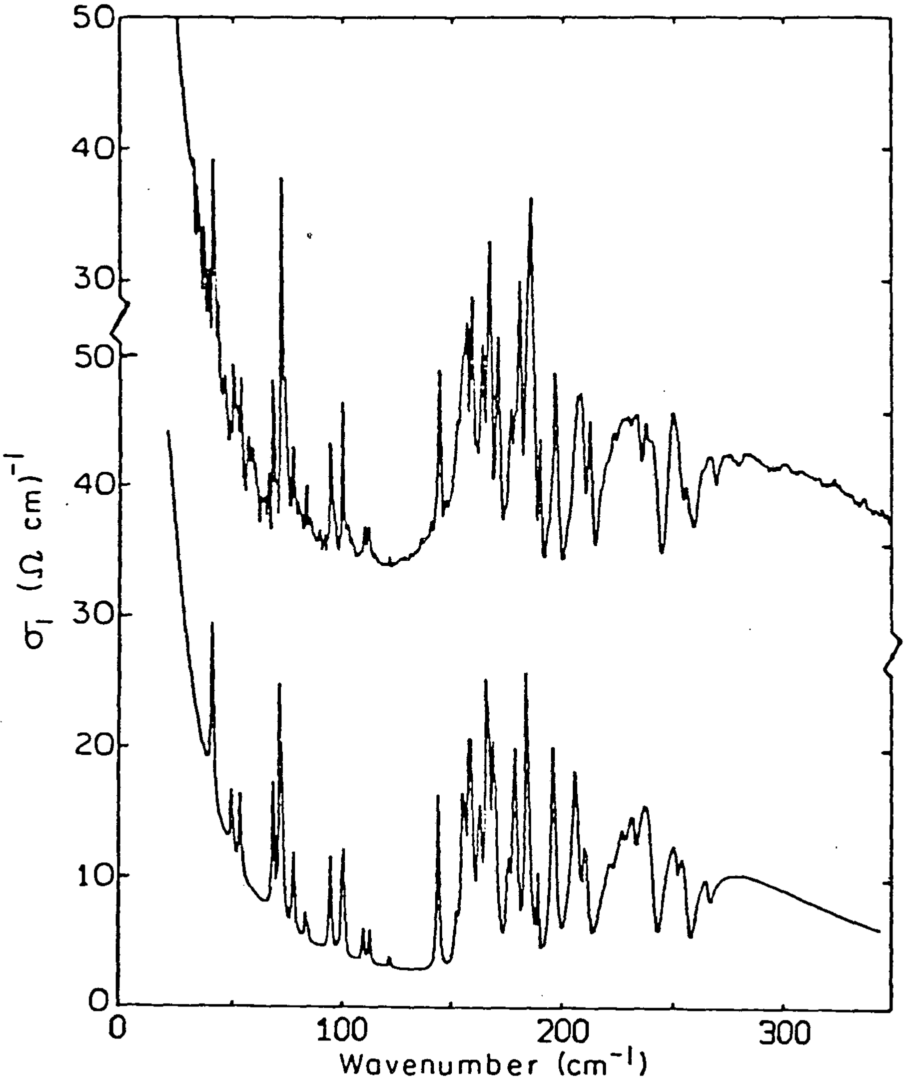

Figure 1. (a) Kramers-Kronig calculation of $\sigma_1(\omega)$ from the measured reflectance. (b) Model calculation of $\sigma_1(\omega)$ fitted to data.

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