

SHORT COMMUNICATION

SEMICONDUCTOR TO METAL TRANSITION IN Hg_2ClF

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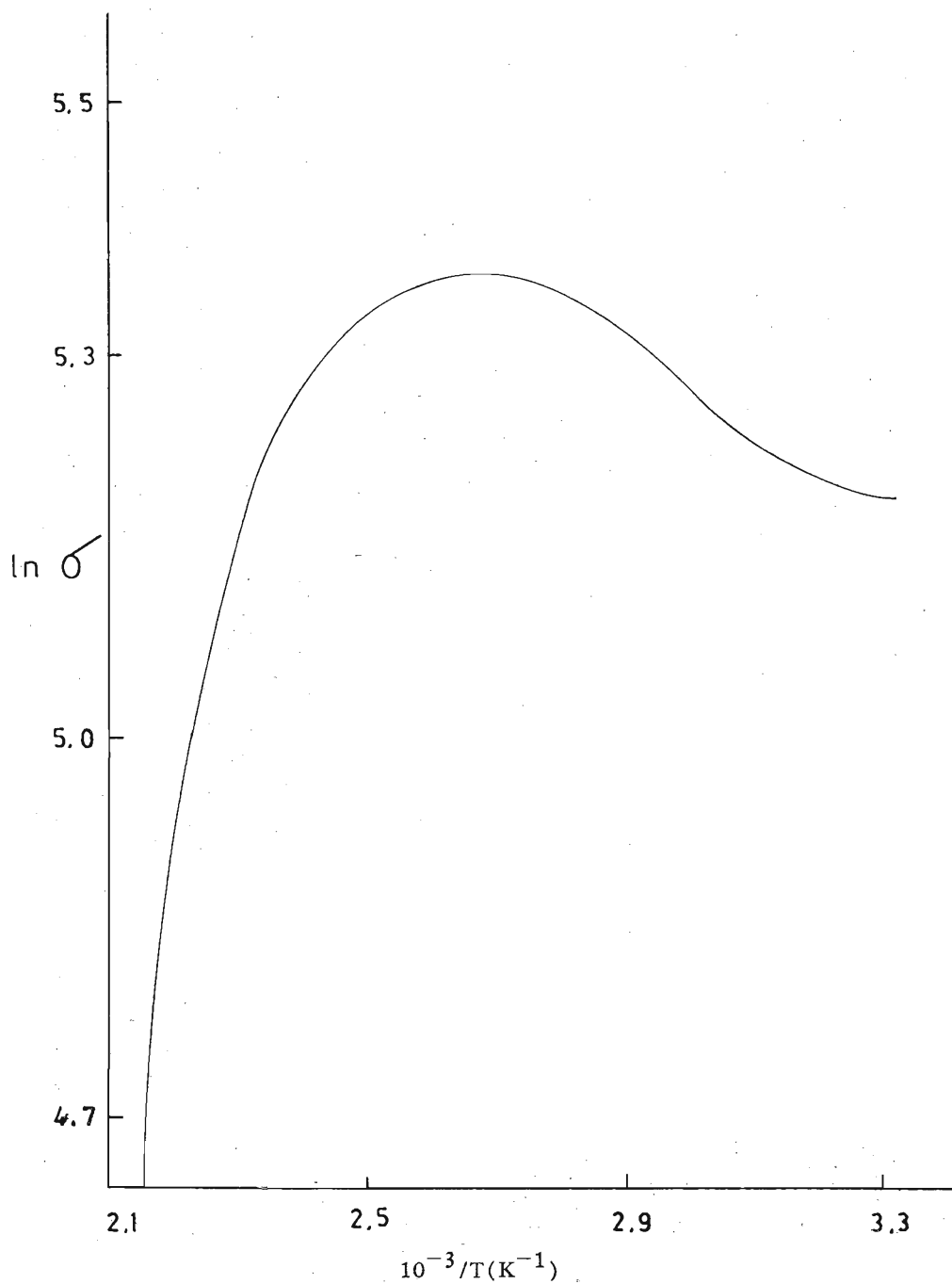
Experimental and theoretical investigations on conductivity transitions in solid materials have attracted much attention. It is well known that some inorganic compounds undergo transition from semiconductor or insulator phase to metallic state upon heating/1-4/. In this note we report our observations on semiconductor to metal transition in mercurous chlorofluoride. This material undergo transition into a metallic state at 369 K and the conductivity in metallic state is unusually high $\approx 177 \Omega^{-1}\text{m}^{-1}$.

Hg_2ClF is prepared by the following method. An aqueous solution of mercurous nitrate (0.1 M) is added dropwise to mixture containing dil HCl and NaF (0.5 M in HCl and 0.5 M in NaF). Hg_2ClF that separates out as a chocolate brown precipitate is washed and dried at 423 K. Chemical analysis indicate that the compound has stoichiometric composition corresponding to Hg_2ClF (molar ratio Hg : Cl : F \in 2 : 1.05 : 0.92).

To measure the conductivity, the powder is compacted into a glass tube (diameter \sim 0.8 cm) and pressed between stainless steel electrodes to a pressure of 2×10^6 pa, when a pellet (length \sim 0.6 cm) is formed. The ends of the tube are sealed with epoxy resin, the sample is immersed in a thermostatic oil bath and the d.c. resistance at different temperatures is measured using a resistance meter (Computing Digital Multimeter, Takeda Riken Model 6877). The room temperature (30°C) conductivity of the material is $177 \Omega^{-1}\text{m}^{-1}$ (quite high for an inorganic compound). The plot of $\ln \delta$ vs T^{-1} is indicated in Figure 1. The transition to metallic state occurs at 369 K and the conductivity thereafter gradually decreases with the increase of temperature, the maximum conductivity is $\sim 215 \Omega^{-1}\text{m}^{-1}$. Current-voltage characteristics are found to be linear at all temperatures. Again polarization effects are not detected and results are independent of the electrode material and a.c. measurements show the same behaviour. Above observations indicate that the conductivity is electronic and ionic conduction is negligible or absent.

Attempts were made to prepare single crystals of Hg_2ClF by diffusion and gel methods, sizeable crystals could not be obtained. Again authors had no facilities to elucidate the crystal structure of Hg_2ClF .

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Figure 1 : Plot of $\ln \sigma$ (σ in $\Omega^{-1} \text{ m}^{-1}$) vs T^{-1}

References

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