R. A. Collins £7

INSULATORS

Filamentary Conduction

from a Correspondent

THE electrical behaviour of insulating materials in the form of thin films is fundamental to the operation of a variety of electrical devices, and in many materials, current transport is believed to occur along filamentary paths in the insulating material. At a meeting on filamentary conduction, held at Imperial College, London, on March 15 and organized by the Thin Films and Surfaces Group of the Institute of Physics, about seventy scientists interested in the conduction properties of thin films discussed in the main two classes of materials: the chalcogenide glasses and the amorphous insulating materials which undergo an electroforming process.

Interest in the chalcogenide glasses arises from their application in the so-called Ovshinsky switches. These are monostable ("threshold") or bistable ("memory") solid-state devices which show current-controlled negative resistance and switching behaviour. The intensive research being undertaken on them was reflected in the four talks delivered in the morning session. Dr A. E. Owen (University of Edinburgh) opened the meeting with a discussion of the mechanisms whereby differential negative resistance and switching occur in chalcogenide glasses and was followed by Dr M. Ingleby (Huddersfield Polytechnic), who reviewed the evidence for electronically-initiated threshold switching. The problems of heat dissipation and how thermal effects modify the electrical characteristics were discussed by Dr J. C. Male (CERL, Leatherhead), and on the same theme Dr C. B. Thomas (RRE, Malvern) considered the effects of temperature on the conduction and switching properties of these materials. It became apparent from these talks that the considerable research effort on chalcogenide glasses has resulted in their basic properties and the nature of the conducting filaments being now fairly well understood.

Knowledge of the properties of amorphous oxides, sulphides and polymers displaying electroforming is considerably less advanced. This became clear from talks in the afternoon session by Dr G. Dearnaley (AERE, Harwell) and Dr R. A. Collins (University of Lancaster). Dr Dearnaley described the electroforming process, whereby application of a d.c. bias to the material results in the development of voltage-controlled negative resistance, electroluminescence and cold-cathode electron emission. He discussed the various theories proposed to describe the properties of these materials and dealt in some detail with the polyfilamentary conduction model which he introduced a few years ago. Following this theoretical review Dr Collins briefly discussed the most recent experimental work on these films, dealing particularly with thin films of cadmium arachidate which exhibit interesting low temperature phenomena. It was evident from this talk that the range of materials which will undergo an electroforming process is so wide, and the variety of their subsequent characteristics so variable, that none of the existing theories is sufficiently comprehensive to explain all the observed phenomena.

The dependence of the electrical properties of silicon oxide films on their method of preparation was discussed by Dr A. Cachard (Villeurbanne, France), who showed how these results might be interpreted in terms of the polyfilamentary conduction model.

The overall picture presented at this meeting was that the chalcogenide glasses are now well understood and that their application to devices will result in continued interest in these materials for several years to come. On the other hand, understanding of the phenomena occurring in "electroformed" thin films is at present insufficient for them to be used in any practical devices.

(Edward Phillips)

INTERSTELLAR MOLECULES

Probing the Background

As testing continues, the possibility that the cosmic background radiation which has a black-body temperature of 2.7 K in the microwave region may attain anomalously high temperatures as observations are extended to shorter wavelengths appears increasingly unlikely. Writing in last week's *Physical Review Letters*, A. A. Penzias, K. B. Jefferts and R. W. Wilson of Bell Telephone Laboratories describe a test in which radio observations of an interstellar cloud of CN molecules are used to obtain a value of the background temperature of $2.25^{+0.6}_{-0.7}$ K (95 per cent confidence limits) at a wavelength of 2.64 mm (**28**, 772; 1972).

This observation is based in the first instance on the fact that interstellar CN molecules tend to be found in the first rotational level rather than in the ground state, the energy difference corresponding to a wavelength of 2.64 mm. Calculations suggest that the population in the first rotational level cannot be due entirely to collisional excitation or to transitions from higher levels. Presumably, then, photons of the background radiation at 2.64 mm wavelength are responsible.

In theory it ought to be possible to determine the temperature of the background radiation at 2.64 mm simply by examining the CN lines in the spectra of stars that are behind CN clouds. The problem is, however, to determine to what extent the population of CN molecules in the first rotational level is to be attributed to collisional processes in the clouds, and hence what corrections have to be made in the determination of the background temperature.

Penzias, Jefferts and Wilson have attempted to deal with this difficulty by comparing measurements of the background radiation made from optical observations of the CN lines with direct measurements of the brightness temperature of the background in the same region. They point out that they are desirous of verifying the optical technique because "this problem of excitation aside, background-temperature measurements based upon such line observations are free of the sources of systematic error common to direct measurement techniques".

In this experiment the 36-foot diameter microwave telescope of the National Radio Astronomy Observatory, installed on Kitt Peak, Arizona, was used to search for 2.64 mm emission from a cloud of CN in the direction of the stars BD+66° 1675 and BD+66° 1674, about one minute of arc apart. Earlier optical observations of the CN lines in the light from these two stars showed excitation temperatures of 2.39 ±0.43 K, and 2.45±0.63 K respectively.

A careful search for the 2.64 mm emission gave a negative result, which is interpreted as meaning that the CN is in equilibrium with the background radiation and that, to the limits of the experiment, there is no extra excitation that should be allowed for in the determinaton of the background temperature. In other words, the excitation temperature of the CN molecules deduced from optical observations of the stars can be equated with the black-body temperature of the background radiation. Thus Penzias, Jefferts and Wilson are able to combine their measurement with the earlier determinations of the excitation temperatures in the directions of the two stars (obtained by J. F. Clauser and P. Thaddeus).

Clearly the result supports the view that the 2.8 K black-body spectrum continues without modification to shorter wavelengths approaching the far infrared. Broad-band measurements of the background flux between 1.3 mm and 0.4 mm have in the past suggested that the background temperature may be anomalously large—around 8 K—although it has not been possible to reconcile all the measurements in this region without assuming a bizarre spectrum for the radiation. Recent measurements have if anything cast doubt on the reality of the anomalous flux, and this recent determination by the Bell Telephones group seems to point the way to even more reliable measurements.