news and views

Thin films: present and future

from Robert M. Hill

TWENTY-FIVE years ago, as part of an undergraduate course, I was introduced to the world of thin films. In an evacuated bell-jar a sample of aluminium wire was heated up by a tungsten filament, the aluminium melted then vaporised and condensed on the cold surfaces of the bell-jar and on a microscope slide mounted in a holder. I think the rest of the experiment was to measure the optical transmittance and reflectance of the semi-transparent metal film. The feature that caught my imagination was the extreme thinness of the metallic deposit, somewhat less than 30 atom layers. For the first time atomic dimensions were realisable, structures could be seen to grow and one could visualise the packing of atom layer on atom layer and investigate the physical effects of size down to angstrom dimensions.

The same period of 25 years has seen an amazing growth in the technology of thin films. New methods of deposition, or rather more correctly, improved techniques based on the development of old ideas have become available, a new range of instruments for investigating the structure and properties of films have been developed and there have been major steps in our understanding of the delicate processes of nucleation and growth, and of the effects of structure on the physical properties of films. A major step in the recognition of thin film science was the establishment, in 1966, of a journal, *Thin Solid Films*, specifically devoted to the publication of scientific papers on thin films and their properties. The journal has now brought out its 50th volume (gone are the days when volumes and years kept pace together) and has taken the opportunity of asking the editorial board and contributors to present their personal views of the past and of the future. Scientists, as we all know, are notoriously reticent about forecasting the long term future, unless one manages to be party to a group relaxing together after a long day listening to interminable papers at a conference or summer school, and there is little crystal ball gazing in this anniversary issue but there is an excellent set of individual views of the past, and particularly the present, state of the field.

The methods of preparation of thin films are many. In this volume alone are descriptions of deposition by vacuum evaporation, chemical vapour deposition, ion beam methods, gaseous adsorption, photodeposition, plasma polymerisation, epitaxial overgrowths and the stacking of monomolecular layers. In principle it seems that any material, element, alloy or compound, can be grown in the form of a thin film. Indeed many alloys can be deposited in metastable forms that are not known in the bulk. The most perfect layers are those grown by epitaxy on single crystal substrates, a technique widely used in the preparation of electronic devices where the interface between film and substrate, or between two different films, of good crystal structure has to be sharp and well defined. Compound formation can be aided by vapour deposition in which chemical reactions are allowed to take place either in the vapour phase or at the growing interface. Much of the recent work on the electrical properties of amorphous semiconductors was carried out on thin film specimens in which the normal crystallisation processes were inhibited by holding the substrate at such a low temperature that the initial surface mobility of the vapour atoms was inhibited and hence the required non-crystalline form obtained.

The wide range of uses of thin films is also clearly shown. The electronics industry is an obvious candidate in these days of planar technology but the dielectric properties of oxides and the low temperature coefficient of electrical resistance of both alloys and mixed metal/dielectric structures have been made use of as capacitors and resistors for many years. A new area of growth is that of integrated optic circuits in which optical signals are processed as they pass along thin surface films of dielectrics, equivalent to flat optical fibres. This is, in some ways, an extension of the already long established use of thin films as blooming coatings on optical lenses and in multi-layer interference filters. Here too there have been many recent advances and new problems uncovered particularly by the use of high energy density optical beams from laser sources. Twenty-five years ago the coating of the Mount Palomar reflector with aluminium was a major task, how many mirrors, prisms and lenses have received a thin film coating since then?

In many areas the future prospect for thin films looks good. Taking only two examples the journal reports significant advances in the thin-film-transistor and in film based solar power cells. By itself the t-f-t cannot compete with silicon technology but for a flat plate television display there is a need for a simple, cheap, mass producible, amplifying device at the end of each (x,y) coordinate. Here thin film technology can play its part and the problems that have been encountered in developing a reliable device are being overcome. The present high cost of solar cells is primarily due to the single crystal silicon used as the starting material. In order to bring the cost down to be comparable with that of conventional power supplies by 1986, as has been proposed, non-single crystal material will have to be used, and in the form of thin layers. The journal reports that thin film technologies should achieve the target on time.

It will be interesting to see what is reported in the 100th volume of *Thin Solid Films*. Perhaps by that time scientists will not be so reticent about the future. For the present the Editors are to be congratulated in giving their authors the chance to look round the field and giving us an end of term report. □

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0028–0836/78/0275—0009$01.00