

## Reflections on surfaces

*Science and Technology of Surface Coating.* Edited by B. N. Chapman and J. C. Anderson. Pp. xvii+463. (Academic: London and New York, 1974.) £14.80; \$41.50.

*Characterisation of Solid Surfaces.* Edited by P. F. Kane and G. R. Larra-bee. Pp. xviii+670. (Plenum: London and New York, 1974.) \$39.00.

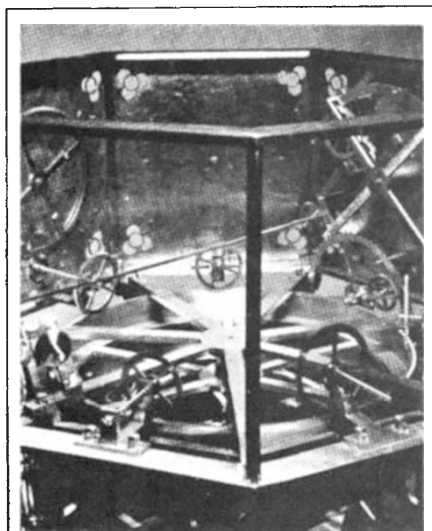
THESE two volumes bring out two immediate observations. First, that both the technology of producing surface coatings and the methods of microstructural analysis have undergone extremely rapid development. Second, that many of the new surface coating techniques still owe more to acute experimental observations and technical imagination than to direct application of scientific knowledge.

These thoughts are provoked particularly by the first volume on surface coatings, the editors of which deserve congratulations on producing in less than 500 pages 44 articles written by enthusiasts. These articles outline the bewilderingly large range of methods currently available for applying surface coatings to useful materials, and indicate some of their applications. It was clearly not possible or desirable in articles of this length to discuss any of the topics at all fully, but all of the articles give an outline of the physical principles involved and in most cases a useful list of references is included.

In addition to those topics that are predictably present—for example, electroplating, evaporation, chemical vapour deposition, and so on—there are other, more unexpected but worthwhile methods discussed. These include well established technologies such as brush painting, printing and spraying; the physics of such technologies being subjects less often considered in the scientific literature. Among the newer technologies, those of plasma arc and flame spraying and detonation bonding of refractory materials are described together with fascinating new ideas, such as that of 'electrical harmonic spraying' in which an electrical potential applied to liquid drops emerging from a tube can produce a collimated beam of liquid drops that are uniformly charged and have constant mass and velocity, such that they can be deflected accurately to form a deposited pattern without the need of a mask. Another idea that seems to be technically 'sweet' was the method of 'ion plating' in which adhesion between a substrate and a coating material can be improved by an increased kinetic energy of the first deposited layer. This increased energy is achieved by ionisation

of the evaporating atoms followed by electrical acceleration onto the substrate.

Two omissions, are, however, striking—'metalliding', the electrodeposition of metals with molten fluoride electrolyte was presented by abstract only; and no discussion was given of the Xerox process. The lack of a full discussion on metalliding was probably no fault of the editors, but at least a list of references might have been obtained from the missing author. The absence of Xerography is disappointing in that many of the coating methods discussed use charged material deposited onto a uniformly charged substrate, so selective deposition onto a partially charged



Modern reconstruction of Giovanni de Dondi's astronomical clock. The original was made in about 1364. From *Gears from the Greeks. The Antikythera Mechanism—A Calendar Computer From ca. 80 BC.* By Derek DeSolla Price. Pp. 70. (Neale Watson Academic: New York, 1975.) \$8.50.

insulator seems a natural extension of these ideas.

The major criticism, however, must be that only a few articles discussed the *properties* of the coatings, and only one considered their structural assessment—either the title should have been 'Methods of Producing Surface Coatings', or more consideration of the properties of coatings should have been given.

*Characterisation of Solid Surfaces* is a very different volume in which a smaller range of topics (23) is considered in greater depth. The analytical methods described range from genuine atomic surface techniques such as Auger spectroscopy, electron spectroscopy for chemical analysis, and field ion microscopy, to techniques normally considered only for assessment of bulk microstructure such as transmission electron microscopy (TEM) and electron probe microanalysis (EPMA). The relevance of such bulk techniques is,

however, clearly justified in that the 'bulk' material studied—100 nm for TEM and 1  $\mu$ m for EPMA—though large compared with a single atomic depth may be appropriate to many surface applications, such as surface coatings.

In addition, as shown by Laird in his excellent discussion of TEM, much genuine surface information can be gained by suitable specimen preparation facilities. The converse of this idea is also discussed—the analysis of bulk microstructure by use of surface analysis combined with erosion techniques so that the bulk can be revealed as a series of exposed surfaces. As a result of this interchange between bulk and surface analysis the content of this book will be of value to all interested in the microstructure of materials; not just to the rapidly growing band of surface scientists.

The techniques described all involve the illumination of surfaces with photons of various frequencies, electrons, ions or neutral atoms, followed by an examination of emitted photons, electrons, ions or atoms. The varied combinations of these techniques has given rise to a large industry both supplying and using increasingly expensive and varied equipment. It is noticeable that only in the chapter on optical microscopy was the cost of the equipment considered in respect to the value of the information obtained.

The rapidly growing arsenal of expensive equipment described indicates the importance of deciding what information is really needed in any application and which method is best for obtaining it. It often seems that scientists may become oriented to using just one technique—that in which they have detailed knowledge—ignoring others that may be more useful. The level of expertise obtainable from most of the chapters in this book should do much to indicate the advantage of other techniques, though for a detailed understanding one would have to make use of the literature cited.

Among the noticeable omissions was a discussion of low energy electron diffraction, though the editors refer to a good review. Perhaps more serious in view of the seemingly inevitable delays between writing and publication was the lack of a list of important references that might have covered the interval between writing and final printing of the volume.

A final and inevitable reflection on these two volumes is the lack of application of the analytical techniques to the evaluation of the structure of surface coatings; one can only hope that these two books will lead to some cross fertilisation between these two groups of surface scientists and technologists.

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