SYMPOSIUM ON ADVANCES IN ELECTRON METALLOGRAPHY AND ELECTRON PROBE MICROANALYSIS

INTRODUCTION

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This is the third ASTM Special Technical Publication presenting techniques developed for electron metallography. The present volume displays a continuation of the trend established in the previous volume, namely, the inclusion of a number of papers involving techniques other than conventional electron metallography. This increased coverage is a reflection of the broadened scope of activities of Subcommittee XI.

The techniques described in the first publications[2, 3] of this series were concerned mainly with surface replication for the study of metallurgical structure. The second publication[3] already demonstrated a diversification of workers' interests into the fields of transmission electron microscopy, electron diffraction, and electron probe microanalysis. This influence has been shown in the activities of Subcommittee XI, which has initiated task groups for cooperative study of techniques in each of these areas. The present volume includes the First Progress Report of the Task Group on Electron Transmission Microscopy of Subcommittee XI which provides information on thin film techniques for iron, stainless steel, and aluminum, and demonstrates the application of this method to the study of certain microstructural features, namely, lattice defects, subgrain boundaries, orientation, and structure. A bibliography of papers in the field of transmission electron microscopy is appended to the Progress Report.

Other contributions to the study of thin film electron metallography include papers by Banerjee, Capenos, and Hauser on techniques and observations on commercial 410 stainless steel; by Phillips demonstrating the direct observation of microstructure in metals sectioned by ultramicrotomy; and by Young, Melton, and Schwartz on zirconium and Zircaloy-2.

Interest in the application of electron probe microanalysis is evident in the paper by Ohh and Carroll, dealing with diffusion in the system iron-nickel, and that by Birks, describing a procedure for calculating element concentrations from the measured X-ray intensities. (This paper has been published elsewhere.[4]) The activities of the Task Group on Electron Probe Microanalysis of Subcommittee XI were presented at the Sixty-fourth Annual Meeting in a Progress Report on "Round-Robin Testing of a Niobium-Iron Diffusion Couple by

[1] Battelle Memorial Inst., Columbus, Ohio.

[2] Symposium on Techniques for Electron Metallography, *ASTM STP No. 155*, Am. Soc. Testing Mats. (1953).

[3] Symposium on Advances in Electron Metallography, *ASTM STP No. 245*, Am. Soc. Testing Mats. (1958).

[4] L. S. Birks, "Techniques for Calculating X-ray Intensities in the Electron-Probe Microanalyzer," *Journal of Applied Physics*, Vol. 31, p. 1297 (1960).

Electron Probe Analysis Methods." This effort is incomplete, however, and it is expected that the completed results will be reported in the future. A classified bibliography of electron probe microanalysis, prepared by members of this task group, however has been included in this volume.

To assist newcomers in the field and to provide an excellent source of information on the many facets of electron metallography, a review paper by Bigelow provides timely data on such subjects as instruments, techniques, and applications, together with an extensive list of references. Wilkins and Pence report on the structure of precipitation hardening stainless steels as observed by replica techniques. These particular alloys are now being examined by Subcommittee XI using transmission electron microscopy, and it is hoped that a report of this investigation will be published eventually. Microstructural evidence of tensile deformation of an age-hardened nickel-base alloy was observed by Madden, Bigelow, and Sponseller. A useful method for the removal of plastic backing films in certain techniques of replica preparation is described by Beals and Bigelow. The morphology of nitride precipitates in 12 per cent chromium stainless steels was investigated by Banerjee, Capenos, and Hauser, using extraction replica techniques.

Finally, two papers are presented, dealing with diffraction methods of structure analysis, which have in common the use of a focused electron beam available in these instruments. One is a paper by Beattie on electron diffraction intensities, which discusses the occurrence of "forbidden" reflections and its importance in interpretation of the data and in its utilization for structure analysis. Last but not least, the paper by Heise describes the very useful auxiliary application of the electron probe analyzer as a point source of strongly divergent characteristic X-rays to produce Kossel patterns. Applications to studies of crystal orientation and to determination of lattice constants are illustrated.

Subcommittee XI is currently engaged in transmission electron microscope studies of thinned precipitation hardening stainless and high-temperature alloy steels, in the development of techniques for electron probe microanalysis, and in the evaluation of techniques for electron diffraction. It is hoped that progress in these areas will be reported at future ASTM symposia.