ded as follows: 1) new X-ray sources; 2) X-ray techniques for the metrology of nanostructures; 3) nanoscale devices for X-ray applications. The scheduling of the 22 formal presentations and the 25 posters followed this scheme, and plenty of time remained for informal discussion between the 70 or so participants, one-third of whom came from industry.

X-ray sources are clearly an essentially ingredient and the workshop considered progress in the design and construction of new types of sources devoted mainly to industrial applications in lithography. High-power excimer lasers are being tested for generating soft X-ray radiation at 13.5 nm [Bijkerk, FOM Rijnhuizen], while a compact synchrotron radiation X-ray source centred on the critical wavelength of 0.84 nm is now available commercially for routine operation [Kempson, Oxford Instruments].

X-ray Reflectometry Develop

In the area of submicron local analysis of microstructures, glancing incidence X-ray reflectometry (GIXR) is now well-established for determining thickness, surface roughness and, more generally, electron density profiles in thin films and layered materials. It can be regarded as complementary to thin-film characterization with X-ray diffraction (XRD), which was discussed by Fewster [Philips Research Labs, UK] and Temst [Katholieke University, Leuven]. Elaborate simulation codes for the analysis of experimental reflectivity curves have become available; they take advantage of Fourier transform techniques [University of Linz; Martin, Lab. Electronique Philips; Bridou, IOTA, Orsay; Voorma, FOM Rijnhuizen] and include refinements such as data correction for sample curvature [Bridou]. The power of the method is increased by adding complementary techniques such as X-ray fluorescence (XRF) and XRD to provide either non-destructive, near-surface analysis with a single instrument [van den Hoogenhof, Philips Analytical X-Ray; Zheludeva, Institute for Crystallography, Moscow]. Spectroscopic and kinetic ellipsometry has also been incorporated for use with *in situ* studies of ultra-thin film growth [Luken, ESRF, Grenoble]. The application of synchrotron radiation as the X-ray source permits an extension of the technique to energy-dispersive reflectivity measurements [Hoghoj, ESRF], and to soft X-ray reflectometry [Krumrey, ESRF] which is being used to calibrate optical devices. The latter illustrates the increasing number of possibilities for research and applications in the soft X-ray spectral range.

Interface Roughness a Key Issue

Complementary to GIXR is glancing incidence X-ray scattering — a relatively new method for surface, thin-film and multilayer characterization, and the subject of intense research, with the interpretation of experimental results based mainly on the distorted wave Born approximation (DWBA). The combination of glancing incidence X-ray reflectivity and scattering measurements should lead to an improved description of surface roughness in terms of the lateral correlation distance or the frequency spectrum [Sinha, Exxon, USA; de Boer, Philips Research Labs, Eindhoven]. The particular case of scattering by periodic multilayers, which have important practical applications, was being studied by many contributors with the view to determining a model for the replication of interface roughness on passing through the multilayers [Holý, University of Brno; Spiller, IBM, USA; Plotz, University of Linz]. A tool for understanding the physical origin of the X-ray scattering, which will allow a quantitatively unambiguous interpretation of the measurements, was introduced by Salditt [University of Munich] and is summarised in the insert.

The DWBA theory accounts for the resonant phenomena which are observed in non-specular scattering from periodic multilayers, and it highlights their connection to X-ray standing waves (XRSW). XRSW generated during XRF measurements of crystalline or layered synthetic structures can be used to characterize ultra-thin layers deposited on these structures [van den Hoogenhof, Philips Analytical X-Ray; Zheludeva] or included in the bulk [Kovalchuk, Institute of Crystallography, Moscow].

Improving Multilayer Fabrication

The development of nanoscale X-ray technology is strongly related to progress in the design and fabrication of nanoscale devices based on layered synthetic microstructures. Some participants reported that the reflectivity of multilayers made by thermal evaporation is increased by ion bombardment of each layer immediately after deposition, and by optimizing the temperature of the mirror. Ion bombardment during deposition is also applied to produce graded refractive index profile multilayers by controlled atom mixing [Verhoeven, FOM Amolf; Louis, FOM Rijnhuizen; Schlatmann, FOM Amolf]. High quality Si/SiN and Si/SiO multilayers produced by reactive sputtering have shown selectivity and thermal stability better than those of the refractory-metal containing Mo/Si multilayers commonly used for EUV mirrors [Houdy, University of Evry]. Magnetron sputtering permits one to produce W/Sb multilayers with periods down to 1 nm, thereby opening the way for normal incidence soft X-ray mirrors in the crucial "water window" spectral range. A maximum normal incidence reflectivity of 13% at a wavelength λ of 4.47 nm has been achieved with a Fe/C multilayer deposited on a silicon wafer [Salashschenko, Nishnii Novgorod].

Industrial applications of soft X-ray projection lithograpy at λ = 13 nm will require sources that have average X-ray power levels which are at least an order of magnitude greater than those usually found today. Optimization of deposition techniques tends to focus on Mo/Si multilayers having a reflectivity above 60% at normal incidence. Achieving this value will not be easy because it is equivalent to only 10% less than the theoretical reflectivity of perfect multilayers [Platonov; Louis].

The proceedings of EIW-9 will be published in *Journal de Physique III* and it was decided to organize a follow-up meeting, probably in Germany in 1995. Finally the Co-chairmen recognize that the workshop would not have been possible without generous financial support from the Commission of the European Communities, Foundation Physica, Newport B.V., Philips Analytical X-ray, and Philips Research Laboratories.

D.K.G. de Boer, *Eindhoven*
J.P. Chauvineau, *Orsay*

EUROPHYSICS INDUSTRIAL WORKSHOPS

Thermal Microsensors: Their Bases, Principles and Applications (EIW-10)
25-28 April 1994
Treff Hotel Panorama, Oberhof, Germany
(40 km from Erfurt)

To promote a wider application by industry of the latest results of research and development.

Sessions: introduction; materials; technologies; applications (4 invited reviews, 30 contributions & posters).

Fee (incl. registration, accomodation, full board, hotel facilities, excursion):
- EPS Members and staff members of EPS Associate Members: DM 750.-
- Others: DM 900.-

Registration deadline: 11 March 1994

Information: J. Müller, Institut für Physikalische Hochtechnologie e.V. (IPHT), Postfach 10 02 39, D-07702 Jena
(tel.: +49-3641-85 25 37; fax: +49-3641-85 25 87).

Industrial Applications of Positron Annihilation (EIW-12)
10-12 March 1994
De Rosep Hotel/Conference Centre, Oisterwijk, The Netherlands
(near Tilburg)

To promote industrial applications of positron annhilation by bringing together industry and specialists from laboratories.

Sessions: Defects in metals; semiconductor materials; technical applications of PET; future developments (invited review talks, contributed presentations & posters).

Fee (incl. registration, accomodation, full board, proceedings):
- EPS Members and staff members of EPS Associate Members: NLG 1050.-
- Others NLG: 1300.-.

Information: Prof. A. van Veen, IRI, Delft University of Technology, Mekelweg 15, NL-2629 JB Delft
(tel.: +31-15-78 38 77; fax: +31-15 78 64 22).

PLASMA PHYSICS DIVISION

Call for Nominations

The term of office of the present Division Board has ended along with the mandate of its Members. The following Board Members are considered eligible for re-election:

J. Bakos (Vice-Chair), Budapest
C.-G. Fälthammar, Stockholm
M. Siegrist, Lausanne
F.W. Sluijter (Chair), Eindhoven
P. Sunka, Prague
F. Wagner, Garching

The Chairman seeks nominations for a new Board (which should have 12 elected members) and asks that they be sent before **16 March 1994** to Mrs. M.A. Coopmans-van Basten, Dept. of Applied Physics, Eindhoven University of Technology, Postbus 513, NL-5600 MB Eindhoven (fax: +31-40-44 52 53; email: ria @ vsrs.ni.phys.tue.nl).