of precision work with a wide range of applications was presented by *J. Kikas* from Estonia. Spectral hole burning of dyes in polymer matrices produces holes with a spectral width as low as 10^{-2}–10^{-3} cm^{-1}. With this resolution, up to 10^3 holes may be burned per inhomogeneous band. The listed applications of such hole burning techniques included frequency selective optical memory, space and time domain holography, and the materials may be used as narrow band optical filters. Application of an external electric field gives rise to stark shifting of the holes, an effect which may be exploited as an optical modulator.

Within one week it is only possible to cover a small portion of the current developments in this expanding field. Presented above is merely a cross-section of the week, but a number of issues were, however, highlighted. Firstly, whereas the nature of the optical and nonlinear optical properties of conjugated polymers are still considered to be primarily determined by interchain effects, the material structure and morphology appears to be critical for the electrical properties. This structure-properties relationship was discussed at length, resulting in the recognition of the need for well defined structures, and systematic studies. In such a way, understanding and enhancement of electrical properties may be achieved through manipulation of material structure. On the other hand, in the case of the nonlinear optical properties of conjugated polymers, the suggestion of an intrinsic molecular limit to the magnitude of the response infers the need for further systematic studies on well defined molecular structures. The division between the two fields of research is highlighted by the fact that good electrical properties require material doping, a process which as a devastating effect on the nonlinear optical properties.

Despite the continuing complexity of both areas, progress towards an understanding of the dominant physical processes involved is being made. The resulting feeling of optimism was reflected in the atmosphere of a conference designed as an exchange between Eastern and Western Europe, held in a country in transition from one political idealogy to the other. Amidst this political, economic, and scientific complexity, the conference was a success.

Surface Modification Technology in Neuchâtel

By Peter K. Bachmann *

The "Third International Conference on Surface Modification Technologies" (SMT III) was held from 28 August–1 September in Neuchâtel, Switzerland. After Phoenix, Arizona and Chicago, Illinois, SMT III was the first of this series of conferences to take place outside the United States of America.

Neuchâtel, beautifully located at the foot of Mount Chaumont and at the shore of Lake Neuchâtel was chosen because it is also the home of the University of Neuchâtel and of CSEM, the Centre Suisse d'Electronique et de Microtechnique S.A., a private, non-profit R&D organization active in the fields of microelectronics, optoelectronics, sensors, micromechanics and material science. CSEM and TSM jointly organized and sponsored SMT III along with many other Swiss scientific societies, Swiss government agencies and the University of Neuchâtel, which provided the rooms and the infrastructure for the conference.

The objective of the "Surface Modification Technologies" conference series is to bring together physicists, chemists, metallurgists, manufacturing engineers, and other materials scientists from around the world to interact and utilize each other's capabilities in the cross pollination of ideas, and, indeed, 82 contributions from 20 different countries including Europe, Asia, Australia and North America are listed in the technical program. Quite interestingly for a conference held in Europe, the USA with 22 papers outnumbered Switzerland with 13 and West Germany with 10 contributions. Japan, on the other hand, had only two entries.

The sessions offered to an audience of approximately 160 participants included ● Diamond and Related Coatings, ● Characterization of Coatings, ● Physical Vapor Deposition, ● Chemical Vapor Deposition, ● Laser Alloying, ● Alternate Coating techniques, ● Laser Surface Treatment, ● Coatings for Space Applications, ● Ion Implantation, ● Electroplating, ● High Temperature Coatings, and were accompanied by an additional half-day poster session.

1. Wear and Corrosion Resistance

Similar to other coating oriented conferences, SMT III illustrated that many practical applications of modified surfaces are related to improved wear resistance or increased

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lifetime of bearings and cutting tools. Contributions to this field were scattered throughout the processing technology oriented sessions and made up approximately 30% of the conference papers. Examples of this topic include a presentation by *O. Knotek* (RWTH Aachen, FRG) on reactively sputtered ceramic coatings. The properties of Si_3N_4 ceramics were improved by adding a thin layer of Si–Al–O–N using reactive magnetron sputtering techniques. *W. Ensinger* (University of Heidelberg, FRG) presented a paper on the low temperature generation of ceramic coatings, for instance nitrides or carbides of boron, titanium, chromium aluminum or silicon using ion beam assisted deposition. Deposition temperatures well below 200 °C were made possible using this technique. *D. G. Bhat* (GTE Valenite, Troy, MI, USA), one of the conference co-organizers describing in his contribution how to improve the chemical wear resistance of Si_3N_4 cutting tools for the machining of steel by applying a computer-modeled titanium nitride layer that adheres excellently to the surface of the tool material.

An alternative to applying vapor deposited coatings to improve the performance of cutting tools was presented by *T. L. Vander Wert*. (Innovex, Hopkins, MN, USA). By applying a pulsed magnetic field to relieve internal stresses the lifetime of any cutting tool material was shown to increase by 40% to 180%.

Another alternative to the deposition of carbide and nitride coatings that has gained attention in the Japanese industries was pointed out by *T. Arai* (Toyota, Aichi, Japan). In this approach, carbon or nitrogen containing materials are immersed into molten salt baths containing carbide or nitride forming elements. The coating is formed by chemical reaction on the substrate surface. The performance of this material is comparable to CVD or PVD coatings but the preparation process was found to be more efficient.

2. Superconductors

This topic was covered in three papers. The results of R.F. magnetron sputtering experiments (by *P. K. Srivastava*, CSEM, Neuchâtel), chemical vapor deposition (by *G. Wahl*, Asea Brown Boveri, Heidelberg) and spray pyrolysis of aqueous Y-Ba-Cu nitrates (by *S. P. S. Arya*, CSEM, Neuchâtel) were outlined. All of the methods are capable of producing the standard 1-2-3 material with transition temperatures around 90 K. The width of the transition region of films made by spray pyrolysis on alumina decreases upon applying a Y_2BaCuO_5 interfacial layer prior to the formation of the 1-2-3 coating.

3. Miscellaneous Coatings and Processes

The preparation of unusual material combinations was tackled by *J. W. Dini* (Lawrence Livermore Laboratory, Livermore, CA, USA) by utilizing combinations of processes. Thick (1 mm) copper coatings on glass which can subsequently be precision machined for optical purposes were obtained by first applying a PVD coating followed by the electroplating of the newly generated surface.

Part of a review by *P. K. Bachmann* (Philips Research Laboratories, Aachen) was devoted to a sucessfully industrialized CVD application, the preparation of high quality optical fibers for telecommunications applications by means of thermal and plasma induced chemical vapor deposition methods. Up to now the stringent requirements of ultraclean processing and the close matching of a desired refractive index profile are only met by CVD techniques. With respect to efficiency, dopability and refractive index profiling, plasma induced CVD has advantages over thermally initiated deposition processes. A number of papers in various sessions were related to the characterization of surfaces modified by laser treatment, plasma treatment, and ion bombardment. Special attention was on the characterization, modification, optimization and modeling of substrate-deposit interfaces to improve the adhesion of deposits.

4. Diamond and Related Coatings

After more than 6 years of continuous research and development efforts in Japan and about 4 years after major US groups entered (or re-entered) the field, CVD grown diamond coatings are now considered a reality in Western Europe. This is illustrated by the first major diamond-related conference session held as part of SMT III as well as by the announcement of the first European conference solely devoted to diamond and related coatings, the "Diamond Films '90" planned for September 1990 in Montreux, Switzerland (for further information, please contact the author). Eight papers and one poster were associated with this emerging technology.

In his invited presentation on diamond as a heat sink material *M. Seal* (D. Drukker, Amsterdam, Holland) provided the link between the well established applications of natural or high pressure synthesized diamond and the utilization of vapor deposited diamond thin and thick films. Diamond is known to be the material with the highest heat conductivity of any solid at room temperature and is applied as a heat sink for high power electronics. When designed and prepared properly, diamond films deposited from hydrocarbon/hydrogen mixtures at low pressure and substrate temperatures of approximately 1000 °C can be used for this purpose thus circumventing the size limitations of natural or high pressure synthesized diamond stones.

As a pleasant surprise to the organizers, *Boris V. Spitzyn* of the USSR Academy of Science in Moscow, USSR, was able to attend the conference. *Spitzyn* has been actively involved in diamond CVD since the early 1950's and was the first to ever apply for a patent on the vapor growth of diamond (on diamond substrates) in 1956. This patent, coauthored by *B. V. Derjaguin*, was finally granted in 1980. He outlined the history of diamond CVD which he rightfully terms diamond "crystallization" from the vapor phase and gave some insight into the basic mechanisms of diamond formation. The main trick is to etch the growing deposit with atomic hydrogen. Due to the higher etch rate, the thermodynamically more stable graphite is removed and pure diamond remains to form a film.

Various preparation methods, including thermal and plasma enhanced CVD techniques can be applied to form polycrystalline coatings on metals, semiconductors and insulators, e.g. Mo, Si and silica glass, as pointed out by *P. K. Bachmann* in the second part of his review on selected CVD applications. He also described applications other than heat sinks, such as cutting tool coatings, loudspeaker membranes, optical coatings and, using semiconducting doped diamond, high power/high speed electronics. Some of these applications are already commercially available, e.g. loudspeakers and certain tools, while additional efforts are still necessary to get the others to the market place. The main problems are currently adhesion for tool applications, scattering of the polycrystalline material for optical applications, and heteroepitaxy of single crystals for larger size electronics applications.

Homoepitaxial growth of diamond on various types of natural diamond is possible, however. In a contribution of *A. Badzian* (Materials Research Laboratory, Pennsylvania State University, PA, USA) the successful preparation of 160 µm thick vapor grown single crystal diamond layers was reported. The differences between the Raman spectra of the substrate and the deposit are neglegible, indicating the high quality of the deposited material. These findings were supported by the X-ray and infrared data of the epitaxial layer. This paper also covered some materials aspects of the C–N and the B–C–N system. The plasma CVD preparation of ternary phases that easily scratch diamond was claimed. Hardening of diamond by the implantation of nitrogen ions was also the topic of *S. Prawer* (Royal Inst. of Technology, Melbourne, Australia). The ion bombardment that improved the wear properties of diamond single crystals had to be applied at elevated temperatures. Another paper on post-growth treatment of diamond, given by *N. Chapliev* (Academy of Science, Moscow, USSR) described the effects of CO_2 laser pulses on CVD diamond surfaces. Pattern etching, the formation of well defined holes and surface smoothing were achieved using different atmospheres during the treatment. Two papers of the session were solely devoted to preparation techniques. *C. Benndorf* (University of Hamburg, FRG) presented a simple set up for microwave plasma CVD of diamond. His modification of this widely used method was to use a cylindrical, tunable resonator along with parts from a commercial microwave oven. Diamond deposition using a DC plasma torch was described by *P. K. Bachmann*. DC thermal plasmas are capable of diamond deposition rates of up to 500 µm/hour on small substrate areas. As pointed out in this presentation, a major drawback is the radially inhomogeneous composition of the coating. Only the central portion of the coating consists of high quality material. Other parts of the deposit are contaminated with graphitic phases. The method is suitable, however, for the preparation of bulk material on small areas. Diamonds also won the prize for "best poster" of the poster session. A presentation by *R. Haubner* (University of Vienna, Austria) outlined the influence of nitrogen added to the CVD gas phase. For nitrogen concentrations of more than 5% (in the gas phase) the crystallinity of the coatings deteriorates. At about 2%, large textured growth regions are observed. They exploited the "heated" filament thermal CVD method to grow diamond. All major preparation techniques currently applied worldwide for diamond CVD were, therefore, represented at SMT III.

SMT III was the first of its kind held outside the USA. The organizers will certainly benefit from this experience and further improve some organizational weak spots. The final program with a valid schedule of the papers should be available at least two weeks prior to the conference to allow attendees to plan their stay. The adjustment of the schedules of parallel sessions is a problem for any major conference and will certainly be improved at the next SMT. Despite these minor problems the conference was highly successful in providing a forum to freely exchange surface related ideas and collect results in various scientific fields. The proceedings of SMT III containing the peer reviewed full length papers will appear in book form (2 vols.) in November 1989 (available from TMS, 420 Commonwealth Drive, Warrendale, PA). The organization for SMT IV is already under way. The conference will be held 2–7 September, 1990 in Paris, France and the abstract deadline is December 1, 1989.

Erratum: In Figure 6 of the article Liquid Crystalline Elastomers by R. Zentel, *Adv. Mater. 1989*, 321; *Angew. Chem. Int. Ed. Engl. Adv. Mater. 28* (1989) 1407; *Angew. Chem. Adv. Mater. 101* (1989) 1437, the frequencies quoted in the legend should read "between 10^{-4} and 10^2 Hz".