DS 5 Internal Symposium “Functional thin films - future applications and challenges”

Time: Monday 14:00–18:00 Room: GER 37

Invited Talk DS 5.1 Mon 14:00 GER 37

Actual trends in optical coatings — •Hans Lauth[1] and Norbert Kaiser[2] — [1]JENOPTIK Laser, Optik, Systeme GmbH — [2]Fraunhofer Institut Angewandte Optik und Feinmechanik

Optical technologies have essential importance as driving forces of innovations in the markets of the 21st century. They are key technologies which create the conditions for a lot of new developments and their applications in the future. Today, optical coating has been regarded as one of the most important segment in optics technology. It can sufficiently improve the performance of the whole optical system, satisfy the function requirements, and therefore is an intensively active research field worldwide.

Optical coatings can be found in nearly every technical application. Meanwhile, it plays a significant role in many fields development. The efficiency of numerous applications and products in innovative and future technology fields is still limited by the quality of optical coatings. All optical coatings rely on control of nanodimensions. Thus, optical coatings are considered as one of the major enabling technologies for further progresses in many innovative applications.

It is a general trend to use shorter and shorter wavelengths. This trend is strongly driven by the lithography market, but other innovative markets too. The demands lead to the physical limits. This needs basic research in the fields of laser radiation - material interaction, material science, physical, chemical and micro - structural properties of thin films and surfaces. A general progress in the deterministic production is reached in Europe in the last years.

Invited Talk DS 5.2 Mon 14:45 GER 37

New Materials Approaches for Advanced Nonvolatile Memories — •Thomas Mikolajick — Infineon Technologies Dresden, Koenigsbrücker Strasse 180, 01099 Dresden

Driven by the rapid development of mobile applications the market for nonvolatile memory devices is rapidly growing. Today, the vast majority of nonvolatile memory devices are based on the floating gate device. The floating gate transistor, however, is facing serious scaling limitations. One path to extend the scalability is to replace the floating gate by a charge trapping material. Moreover, the combination of charge trapping with a localized channel hot electron injection mechanism allows to store two physically separated bits in one memory cell. Floating gate as well as charge trapping memory concepts both suffer from severe performance limitations with respect to write and erase speed and endurance calling for a significant system overhead. A memory that works like a random access memory and is nonvolatile would simplify system design. This, however, calls for new switching effects that are based on integrating new materials into the memory cell. In this talk first the material innovations currently under investigation to extend the scalability of floating gate devices will be discussed. Then the current status and the prospects of charge trapping devices will be reviewed, demonstrating their superior scalability. Finally an outlook to memory concepts that use, ferroelectric switching, magnetic switching, phase change or other resistive switching effects will be given to illustrate how the integration of new materials may solve the limitations of today’s semiconductor memory concepts.

Invited Talk DS 5.3 Mon 15:30 GER 37

EUV Optical Coatings — •Hartmut Enkisch, Stephan Müllender, and Peter Kürz — Carl Zeiss SMT AG; 73446 Oberkochen; Germany

In the semiconductor community, the extreme ultra-violet lithography (EUVL) at 13.5 nm wavelength is considered to be the next-generation technology ensuring both optimum quality and throughput. Presently built lithographic tools make use of deep ultra-violet (DUV, 193 nm) radiation and are based on conventional refractive elements made of glass or transparent single crystals. Since radiation of 13.5 nm wavelength is strongly absorbed by virtually any material this approach is not possible in the EUV range. Therefore, EUVL tools exclusively consist of reflective elements. In order to obtain a sufficiently high reflectance, all mirrors to be operated near normal incidence have to be coated with multilayer coatings. They consist of a periodic stack of spacer and absorber layers possessing different refractive indices at the desired wavelength. These multilayer stacks work analogously to Bragg’s Law and thus have a periodic length of about half the wavelength. Therefore, single-layer thicknesses of 3 to 4 nm have to be obtained. The requirements of the optical performance put stringent demands on the quality of the multilayer coatings, such as periodicity, temporal and thermal stability, lateral uniformity, absolute thickness, and film stress.

— 15 min. break —

Invited Talk DS 5.4 Mon 16:30 GER 37

OLEDs: Organic thin film devices for displays and lighting — •Ralph Paetzold, Arvid Hunze, and Joachim Wecker — Siemens AG, Corporate Technology, Erlangen, Germany

Organic materials can be used to fabricate e.g. electronic circuits, solar cells, light sensors, memory cells and light emitting diodes. Because of their huge market potential especially organic LEDs (OLEDs) are very attractive. Only about 10 years after the feasibility of OLEDs had been demonstrated in 1987 the first product entered the market in car radios. Today monochrome and full color OLED-displays can be found in many applications substituting established flat panel display technologies like TFT-LCDs. This is a consequence of their outstanding attributes: They are self-emissive, thin, video-capable and in addition they show a wide temperature operation range and allow a viewing angle of nearly 180° in conjunction with a low power consumption. As performance has steadily increased over the last years, today OLEDs are also under investigation as next generation light sources. In contrast to inorganic LEDs, they can be built as 2-dimensional flat area light sources that are lightweight, color tuneable, and potentially cheap. This will open up new degrees of freedom in design leading also to completely new applications.

In this contribution we will first introduce the basic principle of OLEDs with a focus on the physical processes that lead to light generation in thin organic films. An overview will be given on the main technologies used to build OLEDs and the current status OLED development is illustrated. The last part focuses on the challenges that have to be overcome to enable a sustainable success in the display and lighting markets.

Invited Talk DS 5.5 Mon 17:15 GER 37

Measurement of nanomechanical properties of low-k dielectric films — •H. Geisler, D. Chumakov, L. Jiang, P. Hofmann, C. Streck, U. Mayer, R.-Q. Su, and E. Zschech — AMD Saxony LLC & Co. KG, Wilschdorfer Landstr. 101, D-01109 Dresden, Germany

Interlayer dielectric (ILD) thin films with permittivities of k=3 are currently implemented in advanced integrated circuits to reduce the interconnect signal delay. According to the International Roadmap for Semiconductor Industries, a long-term goal is the fabrication of ILDs with k-values as close as possible to the physical limit k=1. One possible approach to approximate this target is to integrate nano-porous organo-silicate glass materials. As a drawback, low-k and ultra low-k materials possess much lower Young’s modulus and hardness values than conventional SiO_2 glasses which have been used so far. This is a critical issue since ILD films must withstand patterning, chemical mechanical polishing, etching, thermal cycling and chip-packaging. Their adhesion inside multilayer interconnect stacks must be as good as possible to prevent reliability issues or delamination. As a consequence, the mechanical properties of (ultra) low-k thin films have to be characterized carefully to improve performance and to maintain reliability. Since ILD film thicknesses and Cu-low-k structure sizes are typically in the range of a few hundred nanometers or below, suitable mechanical characterization techniques need to be operated on the nano scale. It is shown that nanoindentation with in-situ probe scanning, special force-modulation AFM as well as global and local adhesion measurement techniques can fulfill this task.