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Chapter 1 : Coatings | Special Issue : Polymer Thin Films

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Deposition[edit] The act of applying a thin film to a surface is thin-film deposition â€" any technique for depositing a thin film of material onto a substrate or onto previously deposited layers. Molecular beam epitaxy , Langmuir-Blodgett method and atomic layer deposition allow a single layer of atoms or molecules to be deposited at a time. It is useful in the manufacture of optics for reflective , anti-reflective coatings or self-cleaning glass , for instance , electronics layers of insulators , semiconductors , and conductors form integrated circuits , packaging i. Similar processes are sometimes used where thickness is not important: Deposition techniques fall into two broad categories, depending on whether the process is primarily chemical or physical. An everyday example is the formation of soot on a cool object when it is placed inside a flame. Since the fluid surrounds the solid object, deposition happens on every surface, with little regard to direction; thin films from chemical deposition techniques tend to be conformal , rather than directional. Chemical deposition is further categorized by the phase of the precursor: Plating relies on liquid precursors, often a solution of water with a salt of the metal to be deposited. Some plating processes are driven entirely by reagents in the solution usually for noble metals , but by far the most commercially important process is electroplating. It was not commonly used in semiconductor processing for many years, but has seen a resurgence with more widespread use of chemical-mechanical polishing techniques. Chemical solution deposition CSD or chemical bath deposition CBD uses a liquid precursor, usually a solution of organometallic powders dissolved in an organic solvent. This is a relatively inexpensive, simple thin-film process that produces stoichiometrically accurate crystalline phases. Langmuir-Blodgett method uses molecules floating on top of an aqueous subphase. The packing density of molecules is controlled, and the packed monolayer is transferred on a solid substrate by controlled withdrawal of the solid substrate from the subphase. This allows creating thin films of various molecules such as nanoparticles, polymers and lipids with controlled particle packing density and layer thickness. The speed at which the solution is spun and the viscosity of the sol determine the ultimate thickness of the deposited film. Repeated depositions can be carried out to increase the thickness of films as desired. Thermal treatment is often carried out in order to crystallize the amorphous spin coated film. Such crystalline films can exhibit certain preferred orientations after crystallization on single crystal substrates. There are two evaporation regimes: Commercial techniques often use very low pressures of precursor gas. Unlike the soot example above, commercial PECVD relies on electromagnetic means electric current, microwave excitation , rather than a chemical-reaction, to produce a plasma. Atomic layer deposition ALD uses gaseous precursor to deposit conformal thin films one layer at a time. The process is split up into two half reactions, run in sequence and repeated for each layer, in order to ensure total layer saturation before beginning the next layer. Therefore, one reactant is deposited first, and then the second reactant is deposited, during which a chemical reaction occurs on the substrate, forming the desired composition. Physical deposition[edit] Physical deposition uses mechanical, electromechanical or thermodynamic means to produce a thin film of solid. An everyday example is the formation of frost. Since most engineering materials are held together by relatively high energies, and chemical reactions are not used to store these energies, commercial physical deposition systems tend to require a low-pressure vapor environment to function properly; most can be classified as physical vapor deposition PVD. The material to be deposited is placed in an energetic , entropic environment, so that particles of material escape its surface. Facing this source is a cooler surface which draws energy from these particles as they arrive, allowing them to form a solid layer. The whole system is kept in a vacuum deposition chamber, to allow the particles to travel as freely as possible. Since particles tend to follow a straight path, films deposited by physical means are commonly directional, rather than conformal. Examples of physical deposition include: A thermal evaporator that uses an electric resistance heater to melt the material and raise its vapor pressure to a useful range. This is done in a high vacuum, both to allow the vapor to reach the substrate without reacting with or scattering against other gas-phase atoms in the chamber, and reduce the incorporation of impurities from the residual gas in the vacuum chamber. Obviously, only materials with a much higher vapor pressure than the heating element can be deposited without contamination of the film. Molecular beam epitaxy is a particularly sophisticated form of thermal evaporation. An electron beam evaporator fires a high-energy beam from an electron gun to boil a small spot of material; since the heating is not uniform, lower vapor pressure materials can be deposited. Typical deposition rates for electron beam evaporation range from 1 to 10 nanometres per second. In molecular beam epitaxy MBE , slow streams of an element can be directed at the substrate, so that material deposits one atomic layer at a time. Compounds such as gallium arsenide are usually deposited by repeatedly applying a layer of one element i. The beam of material can be generated by either physical means that is, by a furnace or by a chemical reaction chemical beam epitaxy. Sputtering relies on a plasma usually a noble gas , such as argon to knock material from a "target" a few atoms at a time. The target can be kept at a relatively low temperature, since the process is not one of evaporation, making this one of the most flexible deposition techniques. It is especially useful for compounds or mixtures, where different components would otherwise tend to evaporate at different rates. It is also widely used in the optical media. It is a fast technique and also it provides a good thickness control. Presently, nitrogen and oxygen gases are also being used in sputtering. Pulsed laser deposition systems work by an ablation process. Pulses of focused laser light vaporize the surface of the target material and convert it to plasma; this plasma usually reverts to a gas before it reaches the substrate. If a reactive gas is introduced during the evaporation process, dissociation , ionization and excitation can occur during interaction with the ion flux and a compound film will be deposited. Electrohydrodynamic deposition electrospray deposition is a relatively new process of thin-film deposition. The liquid to be deposited, either in the form of nanoparticle solution or simply a solution, is fed to a small capillary nozzle usually metallic which is connected to a high voltage. The substrate on which the film has to be deposited is connected to ground. Through the influence of electric field, the liquid coming out of the nozzle takes a conical shape Taylor cone and at the apex of the cone a thin jet emanates which disintegrates into very fine and small positively charged droplets under the influence of Rayleigh charge limit. The droplets keep getting smaller and smaller and ultimately get deposited on the substrate as a uniform thin layer.

Chapter 2 : Plasma Characterisation | Neutral Analysis

A review of recent developments in the field of thin film physics, its technology and applications. The volume includes methods and applications, results obtained using classical methods, and new.

Physical vapor deposition and reactive sputtering Physical vapour deposition PVD techniques are widely used for synthesis of various thin films from laboratory to industrial scale. This module aims at understanding principles of the different PVD techniques and highlights the relation between the process conditions and properties of the resulting films. Special focus is paid to plasma-based techniques, the effect of plasma chemistry and ion assistance is discussed. To illustrate various physical processes, challenges related to low temperature synthesis of photocatalytic materials, high deposition rate of compounds, and growth of transparent conducting oxides are discussed. The specific aspects to be covered in this module are: Chemical vapor deposition Chemical methods for synthesis of nanoengineered films and coatings, such as chemical vapor deposition CVD , plasma-enhanced CVD PECVD , and atomic layer deposition ALD , are in the forefront of the thin film science and technology, due to their potential of accurate control of the film chemistry, process scalability, and cost effectiveness. In this module, an introduction to these techniques will be presented; it will include the basic principles, reactor design considerations, reactor optimization, and the role of kinetics on the film microstructure. A review of the nanoengineered films and coatings grown by these techniques, with emphasis to metal nitrides, will be provided. The formation of multicomponent nitride films and coatings by these techniques will be considered, and the factors that are used to produce nanocomposites or ternary and quaternary nitride alloys will be critically evaluated. Finally, a critical comparison with the corresponding PVD films and coatings in view of the potential industrial applications will conclude the module. Thin film nucleation and growth Thin-film technology is pervasive in many applications, including microelectronics, optics, magnetics, hard and corrosion resistant coatings, micromechanics, etc. Progress in each of these areas depends upon the ability to selectively and controllably deposit thin films thickness ranging from tens of angstroms to micrometers with specified physical properties. This, in turn, requires control -- often at the atomic level -- of film microstructure and microchemistry. In this module, the fundamental mechanisms that control vapor condensation, atomic diffusion, island nucleation and growth, island coalescence and coarsening, and continuous film formation will be described briefly discussed. The effect of energetic bombardment on film microstructural evolution will also be highlighted. Stress generation and evolution during film growth The presence of stress in thin films and functional coatings constitutes a major concern in many technological applications, as excessive residual stress levels can dramatically affect the performance, reliability, and durability of material components and devices. This module will start with a description of residual stress sources in PVD thin films, with focus placed on intrinsic stress. Stress evolutions during film growth and post-deposition treatments will be presented, and the underlying atomistic and microscopic mechanisms will be discussed in the framework of a kinetic model. Experimental methods for measuring stress in thin films will be reviewed, based on recent advances in optical, X-ray diffraction and FIB-based techniques, allowing a depth-sensitive determination, as well as real-time diagnostics. The influence of microstructure grain size, texture and deposition process parameters on the stress development in PVD hard coatings will be outlined. The role of energetic species, which are typically present during magnetron sputtering or ion-beam assisted deposition, on the compressive stress build-up will be highlighted. Finally, strategies to control and mitigate stress and stress engineering for specific applications will be proposed. Optical properties of thin films and plasmonic materials Plasmonics has emerged as a dynamic research field that is a direct manifestation of nanoscience, due to the feature sizes of the relevant materials, although their basic theory is classical; as a field it promises radical innovations in biotechnology, in terms of both biosensing and therapeutics, photocatalysis, and telecommunications. Plasmonics are based on nanostrutured conductors. Conductive nitrides have emerged as important candidates for this technology, due to their exceptional stability, despite of some drawbacks. In this module an introduction to the theory of plasmonics will be presented. The optical properties of noble metals, along with other metals and conductive ceramics will be critically reviewed and their potential as plasmonic materials will be cross-evaluated. Based on this comparison, the potential of conductive nitrides as plasmonic materials will unravel and the potential applications, that are specifically tailored for their optical performance, will be proposed. Finally, the techniques for the formation of nitride plasmonic nanostructures following either the top-down approach such as e-beam lithography or the bottom-up approach such as self-assembly growth will be presented and assessed. Computational tools of design of thin films Without doubt, modelling represents an integral part of materials science. It can be used for proving experimental hypotheses, to provide insights beyond the experimental capabilities resolution in space and time, separating various effects etc. Importantly, it has now reached stage where modelling can be effectively used to guide experiments. In this module, we will review various techniques spanning from continuum mechanics and classical thermodynamics, over mesoscale techniques such as discrete dislocation dynamics and atomistic approaches, i. For each technique we will discuss its principles, typical applications with a special focus on thin films , advantages and shortcomings. We will also stress the need for constant cross-checking with experiments to validate the predictions, but also to steer the modelling efforts, hence leading to "experiment-guided theory". He received his Ph. He conducts research on a range of topics related to nanoscale thin films, including mechanical, electrical and optical properties of metallic, nitride or oxide systems, as well as hard and protective coatings in the form of nanocomposites or multilayers. His current research interests focus on the understanding of thin film growth dynamics using real-time and in situ diagnostics, with main emphasis on the stress development during sputter-deposition of polycrystalline and epitaxial layers. He has co-authored more than peer-reviewed papers and serves as Editor of Surface and Coatings Technology journal since Since he is also a guest researcher at TU Wien. His strong expertise includes DFT modelling of alloying trends in nitrides and oxides, in addition to other material classes, e. He has published over peer-reviewed papers and has presented 12 invited talks at international conferences. He teaches several courses on materials modelling and solid-state physics. Tomas is focusing on highly ionized deposition techniques and novel techniques for high quality thin films, especially oxides, for electronics and energy applications. He received his B. His research interests include the growth of films and nanostructures by vapor techniques, their structural characterization via X-Ray and neutron methods, the surface science, spectroscopy and the optical properties of thin films and nanostructures, and the fabrication of electronic, photonic and plasmonic devices. He is engaged with the research on conductive nitrides for over 20 years. His current research interests focus on the implementation of conductive nitrides in photonic and plasmonic devices. He authored or co-authored more than peer-reviewed papers and has served as Guest Editor of numerous volumes of Elsevier journals. He holds a Ph. He has co-authored 50 papers and 4 book chapters, and he has presented 15 invited talks at international conferences and schools. He teaches courses related to thin-film physics at both undergraduate and post-graduate level.

Chapter 3 : Thin Film Materials-Overview and Common Applications -

Optical Diagnostics for Thin Film Processing is unique. No other volume explores the real-time application of optical techniques in all modes of thin film processing. The text can be used by students and those new to the topic as an introduction and review of the subject.

Thin film dressing 10 is typically transparent in nature and normally encased in an outer packaging to keep thin film dressing 10 sterile. Thin film dressing 10 has two surfaces. The purpose of film backing layer 14 is to provide protection to an adhesive area 18 applied on the outer edges on one surface of thin film dressing Thin film dressings 10 are extremely thin ranging in microns and are very flexible. Support frame 12 provides assistance during application and allows for easy handling. Support fame 12 helps reducing unwanted folding of thin film dressing 10 when thin film dressing 10 is applied to various surfaces. Note that removal of the film backing 14 exposes an adhesive area 18 primarily found toward the outer edges of thin film dressing 10 leaving a non-adhesive area 16, in this example, in the center of thin film dressing This non-adhesive area 16 is the part of thin film dressing 10 that is in contact with an acoustic window 24 found on ultrasound transducers Acoustic window 24 is the contact surface between ultrasound transducer 22 and a body A custom molded standoff pad 26 is employed during ultrasound imaging and ultrasound therapy to provide compliance. Additionally, custom molded standoff pad 26 assists in imaging superficial structures during an ultrasound exam. Note that a transmission gel 20 has been applied to the surface of acoustic window Transmission gel 20 is used to insure contact between the inner surface of custom molded standoff pad 26 and acoustic window 24 eliminating air which reduces the flow of ultrasound waves emitted from transducer Note that custom molded standoff pad 26 increases the size and weight of transducer Further, many custom molded standoff pads 26 are not translucent which interferes with visualizing an area of anatomy being scanned by a sonographer. This lack of visualization leads to increased difficulty of performing ultrasound guided procedures i. Typically, these sheaths 28 are loose covers that envelope transducer 22 with a primary purpose to keep a person or animal from coming in direct contact with transducer Sheath 28 has inherent problems the least of which is increased difficulty of handling linear array transducer Transmission gel 20 is a necessary component added to the inside of sheath 28 before inserting transducer 22 within. Although transmission gel 20 does help to insure efficient transfer of ultrasound waves from transducer 22 through sheath 28 into a body 34, this same transmission gel 20 causes increased handing problems. Transducer 22 becomes slippery due to transmission gel 20 increasing the probability of dropping transducer Further, few sheaths 28 actually conform to the shape of transducer 22, thus most sheaths 28 require the use of a rubber band 30 to help secure sheath 28 to the outer surface of transducer Note that left hand 38 holds standoff pad 32 at the same time right hand 36 holds transducer Transmission gel 20 is placed between disposable standoff pad 32 and transducer In addition, transmission gel 20 is also required between disposable standoff pad 32 and body Transmission gel 20 insures free transmission and travel of ultrasound waves from a transducer through disposable standoff pad 32 into body Although disposable standoff pads 32 do provide some protection and avoid direct contact between transducer 22 and body 34 there are some inherent problems using these devices. First of all a sonographer must hold transducer 22 with one hand 36 and disposable standoff pad 32 with another other hand This obviously prevents a sonographer from making important adjustments to an ultrasound machine while imaging or providing treatments. Further, such disposable standoff pads 32 increase the difficulty of imaging large surfaces of a body 34 by having to move both transducer 22 and disposable standoff pad The first image FIG. Transducer 22 is now seen in FIG. Note that no transmission gel 20 is applied below the surface of thin film dressing 10 during the application to transducer Here acoustic window 24 is completely sealed by thin film dressing Again one should note that no transmission gel 20 has been applied to the surface of the acoustic window 24 before application of thin film dressing 10 over acoustic window Thin film dressing 10 is depicted covering almost the entire external transducer 22 and completely conforms to the exterior shape of transducer Starting from the left, a convex transducer 40 having a round body is cover utilizing thin film dressing Next are two convex probes the first being an abdominal transducer 44 and the other a micro-convex cardiac probe The last probe illustrates a square distal surface Thin film dressing strip 50 has film dressing backing layer 14 along with film dressing support tab 54 on each end. Backing layer 14 covers and protects the adhesive surface of on adhesive film strip Adhesive film strip 50 can be seen being applied to linear array transducer 22 in FIG. Support Tab 54 located on each end of thin film dressing strip 50 assists in the application FIG. Note the acoustic window 24 which is contact surface of transducer 22 that comes in direct contact with a body 34 being imaged or treated is covered by thin film dressing strip Also note that no contact media such as gel 20 need be applied to between the inner surface of thin film strip 50 and acoustic window Thin film dressings 10 are generally moisture vapor permeable to permit the covered area to breathe. Polyurethane and elastomeric polyester films 10 are sufficiently elastic to conform to various contours. These films 10, because of the thinness and flexibility, utilize a delivery system such as a paper frame 12 to assist in the application of the thin film dressing Thin film dressings 10 are sterile and individually packaged. Thin film dressings 10 are coated on one surface with a medical grade pressure-sensitive adhesive The adhesive 18 is protected with a covering of a release paper 14 or other backing 14 which can be readily removed at the time of use. Transducers 22 may be used for many years to treat or diagnose a number of conditions. After removing thin film dressing 10 from its protective packaging FIGS. Next, thin film dressing backing 14 is then removed exposing an adhesive coated surface 18 that covers the outer area of thin film dressing In the central portion of thin film dressing 10 exists an area that lacks adhesive This non-adhesive area 16 varies in size and is intended to be large enough to accommodate and cover the entire surface of an acoustic window 24 typically located at the distal end of transducer 22, FIG. Acoustic window 24 usually is made up of a number of piezoelectric crystals that are covered by a membrane. Its is felt that applying a thin film dressing 10 with an adhesive 18 that affixes to the surface of the acoustic window 24 may cause damage to transducer 22 during the removal of the thin film However, other transducers 22 may be constructed such that acoustic window 24 is designed to have a thin film adhesive dressing 10 with an adhesive 18 in the central portion of thin film dressing 10 applied and removed. Applying Thin Film Dressing 10 to Transducer Directing attention to FIG. Next, thin film dressing 10 is stretched, pulled proximal, and applied to each side of transducer Adhesive area 18 on thin film dressing 10 sticks to each side of transducer 22 upper right. Once thin film dressing is affixed to transducer 10, the operator removes support frame 12 from thin film dressing Lastly, thin film dressing 10 is then applied to the remaining sides of transducer No transmission gel 20 is need below the surface of thin film dressing A profile view of transducer 22 is depicted in FIG. There are no air pockets between thin film dressing 10 therefore no transmission gel 20 is required. Ultrasound wave freely traverse thin film dressing Thin film dressing 10 is transparent therefore an operator may easily observe if any air were to be trapped below thin film dressing surface Further, it should be noted that thin film dressing conforms in shape and adheres to transducer 22 exterior surface in addition to acoustic window Covering a transducer 22 with ultra light weight thin film dressing 10 in this manner offers protection for patients while at the same time does not change the shape, size, or appearance of transducers 42, 22, 44, 46, A small thin adhesive film strip 50 may be just enough in some cases to cover and protect a patient from the transfer of micro-organisms. Adhesive Strip 50 is constructed with a film backing 14 and support tab 54 on each end to enhance handling. Application of thin film dressing 10 is the same as described above. Using a sterile thin film dressing 10 in this fashion provides an additional advantage of having a clean surface available when using a reusable custom molded standoff pad SUMMARY AND SCOPE After reading the fore stated description of the protective thin film dressing 10 for therapeutic and diagnostic ultrasound it becomes apparent that this invention provides a novel method of protecting and covering a transducer 22, acoustic window 24, and standoff pads 26, This same device provides for a cost effective way to reduce the transfer of micro-organisms between a transducer 22 and a body surface This invention offers a number of additional benefits including: Covering an acoustic window 24 without having to place transmission gel 20 below the film dressing 10 surface. Covering a transducer 22 with a thin film dressing 10 which will not change the shape of the transducer Covering a transducer 22 with a thin film dressing 10 that reduces the transfer of micro-organisms between the transducer 22 and the subject being imaged or treated. Covering the acoustic window 24 with an adhesive thin film 10 or strip of film 50 which does not impede ultrasound waves. Applying a thin film dressing 10 to cover a standoff pad 26, 32 which provides a clean surface for contacting a body 34 during an ultrasound exam or therapeutic treatment. Utilizing a thin film dressing 10 or thin film dressing strip 50 to protect both humans and animals during a diagnostic ultrasound exam or therapeutic ultrasound treatment. The central concept of a thin film dressing 10 being applied to the external surface of a probe 22 to include covering an acoustic window 24 may be achieved by several varying methods of application without deviation from the intent of this invention. A thin film dressing 10 may be produced in sheets, rolls, or other practical form, with or without a dispenser. A dispenser may be affixed to transducer 10 or a free standing device. Size or exact dimensions of thin film dressing 10 including film 10 thickness may vary providing that thin film dressing 10 remains flexible enough to accommodate different shaped probes 22, 40, 42, 44, 46, 48 and at the same time does not effect the quality of an ultrasound image or treatment. Further, presence of an adhesive or absence of an adhesive on area of thin film dressing 10 shall all be deemed acceptable variations that still fulfill the intent and use for a protective thin film dressing 10 for ultrasound transducers. While the invention has been explained by a detailed description of certain specific embodiments, it is understood that various modifications and substitutions can be made in any of them within the scope of the appended claims that are intended also to include equivalents of such embodiments. A protective ultrasound transducer dressing for diagnostic and therapeutic ultrasound applications comprising: An ultrasonic transducer acoustic window protective dressing for contact with a body for diagnostic applications and therapeutic treatments comprising: The method of applying a thin film dressing to an ultrasound transducer having an acoustic window comprising the steps of: A method of temporarily protecting an ultrasound transducer having an acoustic window from the transfer of micro-organisms or other contaminants during an ultrasound exam or treatment comprising the steps of: An ultrasonic transducer in accordance with claim 1 wherein: An ultrasonic transducer in accordance with claim 5 the thin film dressing thickness is in microns. An ultrasonic transducer in accordance with claim 4 the transducer is a linear array transducer. An ultrasonic transducer in accordance with claim 1 the thin film dressing conforms to the shape of a plurality of different probes.

Chapter 4 : Science & Applications of Thin Films, Conference & Exhibition - SATF

For each technique, the underlying principles are presented, modes of experimental implementation are described, and applications of the diagnostic in thin film processing are analyzed, with examples drawn from microelectronics and optoelectronics.

Chapter 5 : calendrierdelascience.com | Optical Diagnostics for Thin Film Processing | | Irving P. Herman |

This volume describes the increasing role of in situ optical diagnostics in thin film processing for applications ranging from fundamental science studies to process development to read full description.

Chapter 6 : Thin Films - Physical Electronics Inc.

Volume is indexed by Thomson Reuters CPCI-S (WoS).The proceedings of this Symposium cover a broad range of areas concerned with thin film research and applications. Particular emphasis is placed on the properties of thin films and their final application in modern technology.

Chapter 7 : Thin film - Wikipedia

Read "Optical Diagnostics for Thin Film Processing" by Irving P. Herman, Ph.D., Massachusetts Institute of Technology with Rakuten Kobo. This volume describes the increasing role of in situ optical diagnostics in thin film processing for applications rangin.

Chapter 8 : Trends and New Applications of Thin Films

The tutorial aims at providing an overview of: (i) thin-film vapor-based synthesis techniques, (ii) fundamental atomic-scale processes and phenomena encountered during vapor-based film deposition, (iii) theoretical and computational tools used for thin-film design, and (iv) modern and emerging applications of nanoengineered thin films and coatings.