A STUDY ON POLYMER THIN FILMS

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Abstract: Thin polymer films have numerous technological applications in various industrial and biomedical sectors related to protective and functional coatings, non-fouling bio surfaces, biocompatibility of medical implants, separations, advanced membranes, microfluidics, sensors & devices, adhesion, lubrication and friction modification. Development of polymer electronic devices is one of the most interesting and required in the recent year industrial technology. These characteristics are including light-weight, mechanical flexibility, high-dielectric strength, fracture tolerance, high chemical resistance, easy processibility, and low manufacturing cost. Moreover they can be configured into almost any conceivable shape and their properties can be tailored to suit many applications. Nowadays and near future exactingly, electronic-polymer represents an important piece of the electro-chemistry and many technological advances. Thus come from the combination of different materials in electrochemical cells.

Keywords- Polymers, Multilayers, Dielectric Properties, Diblock Copolymers.

INTRODUCTION

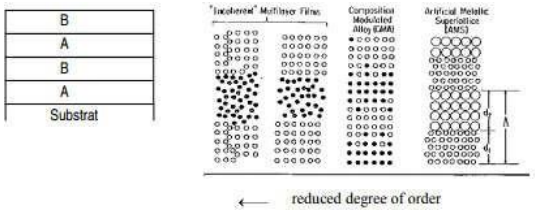
New electro-active polymeric materials are always in the priority market requirements, with different properties, such as electroluminescence, semiconductor behaviour, electronic and ionic properties, electrochromism, etc (De Paoli & Gazotti, 2002; Noh et al., 2006). Wide range of electronic components from micro to nano scales are in research from academics, industry, and national laboratories to present and discuss the recent research and commercial advances and needs. The researchers focus on the topics related to materials development, characterization, processing, manufacturing, analysis, device designing, implementation and applications. The need for such nanoscale and microscale are demanding requirements for polymers as dielectrics, which have been used for insulators and charge-storage applications. Exploring polymer-based dielectrics with extremely low-k and high-k has recently become an important area of research and development.

The influence of environment on electrical insulation and space-charge properties is the access topic for research on dielectric polymers (Taylor, 2006). Recently, a significant highly competition in the markets of the tiny electronic chips technology specially and an extremely demands in the mobile industry and computer manufacturing. The future of electronic chip technology depends on the development of dielectric materials with low dielectric constant (K less than 2.2). The channel length of chip device approaches 0.1 μm, the travailed signal delay on an integrated circuit chip is dominated by the interconnect wiring.

POLYMER DIELECTRIC PROPERTIES

Understanding of polymer molecular dipole influences and field interactions on dielectric characteristics is a fundamental issue for the development of electronic device applications. Three type s of interaction of the polymer molecule with the electrical field (polarization) can be determined. These are possibly to be classified as electronic, atomic and orientation polarization. In the area of thin film, molecule orientation polarization is the most essential. The electrical field tries to align the dipolar molecules along its own direction. This effect is hindered by thermal motion of the molecules. As a consequence orientation polarisation decreases when the temperature increases.

MULTILAYERS



• are artificially typically in nm-range structured and modulated layered systems
• problem, degree of ordering
Thin film = size reduction of bulk material in one dimension

POLYMER **SURFACES**

Air / vacuum
Polymer surface
Polymer volume

(bulk)

MICROSCOPICAL VIEW:

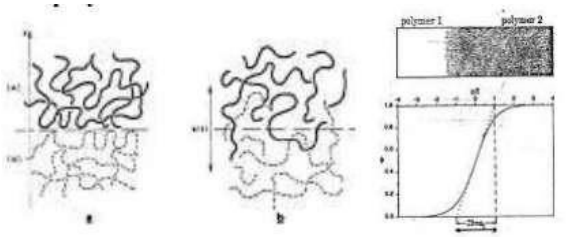
at the surface neighbors are missing (in comparison to bulk)

→ Change of the structure near the surface

TEMPERATURE DIELECTRIC RELAXATION

Mort and Pfister (Mort & Pfister, 1982) have shown that several distinct dielectric relaxation processes can exist in solid polymers. This is observed more clearly when the dielectric loss is studied as a function of the temperature at a given frequency. As the temperature increases, the molecular mobility of the polymer increases leading to more dipole orientation. By convention, the dielectric relaxation processes are labelled †ā ŧ and so on, beginning at the high temperature end. The same relaxation processes are generally responsible for dispersions when mechanical properties are considered, although a particular molecular rearrangement may produce a stronger dielectric than the mechanical effect, or vice versa.

INTERFACES BETWEEN POLYMERS



Most polymers are immiscible (like for instance PS/PMMA),
But sometimes interdiffusion of polymers (for instance PMMA/PVC)

FORMATION OF POLYMER FILMS FROM SOLUTION

we go from very simple techniques for thick films to more and more sophisticated techniques for thin films, even to multilayers ("it is an art, design to prepare them") and single monolayers.

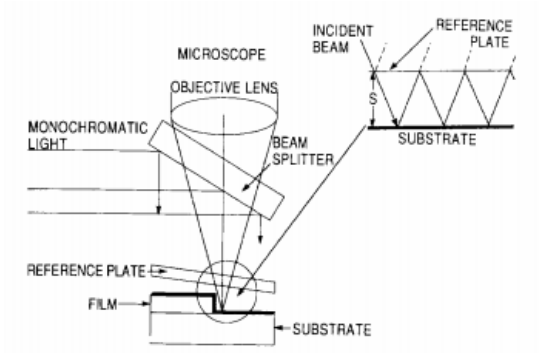
Solvent casting, painting

• Most simple technique
• Preparation of relatively thick films >µm
• Polymer solution is deposited on a substrate – drying – solid film
• For instance: one takes a brush and simply paints the solution on a substrate (wall)
• is of large technical importance: coatings of houses, bridges,…. (protection against rust, water,)
• Thickness often inhomogeneous, depending on the viscosity of the fluid, evaporation rate of the solvent.

DETERMINATION OF FILM THICKNESS BY OPTICAL TECHNIQUES

Widely used. Measurements are nondestructive, relatively inexpensive.

Interferometry relies on the interference of two or more beams of light, e.g. from the air/film surface and the film/substrate interfaces, where the optical path difference is related to film thickness.



THERMAL SPRAY PROCESSING OF POLYMERS ("GUN")

Thermal spraying of polymers is gaining increased attention because the ability to apply coatings of polymers onto a wide variety of materials is seen as an effective method to produce protective barrier coatings.

Polymers that have been sprayed to date include PE, PMMA, EMMA, PEEK, PPS, LCP, nylon, phenolic epoxy, Tefzel, and post-consumer commingled polymer.

Polymer powder is injected into a heat source (flame or plasma) and transported to a preheated substrate. The thickness of the coating is governed by the number of repeated passes of the spray gun across the substrate. A large particle size or molecular weight distribution may facilitate the formation of numerous heterogeneity's within the microstructure of the coating creating voids, trapped gasses, unmelted particles, splats, and pyrolized material.

SPECIAL: FREE STANDING POLYMER FILMS

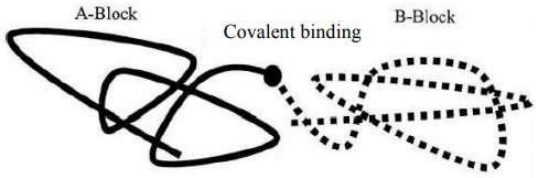
Extremely interesting as model systems to investigate finite size effects on liquids without any interaction with substrates.

Prepared by spin casting thin polymer films (here PS) on a glass substrate and floating them on a water surface. Then they are picked up by an aluminum disk with a 5mm hole in its center.

Then annealed at 160^{o}C in UHV, well above the glass transition temperature of about 100^{o}C. After quenching the film is completely relaxed and should show liquid like behavior. Properties investigated: density profile perpendicular to the surface, the in-plane correlation function and cross correlations between the surfaces.

Multilayers: diblock copolymer thin films - self organization

Often, a polymer may have a particular, desirable property but processing is difficult or the polymer´s surface characteristics are undesirable. To circumvent such shortcomings there exists the option to mix two polymers with complimentary properties. Unfortunately, most polymers are immiscible unless there are specific interactions (e.g. H bonding) between the two components. Consequently, coarse phase separation is often observed.



Diblock copolymer: two polymers are bounded over chemical binding Poly (A-b-B).

But in special cases, two chemically distinct homopolymers can be joined together at one point, forming a diblock copolymer. While phase separation may occur, the scale of the domains is restricted to the sizes of the individual homopolymer, which is typically on a scale of tens of nm. An advantage is furthermore that the size of different blocks can be altered by varying the concentration of the different components.

Example: PS poly(styrene) – PMMA poly(methylmetacrylate)

Conclusions

In this paper we study on what is polymer Thin Films and explain the properties on dielectric polymer, Multilayers, polymer surfaces, Microscopical View, Temperature dielectric relaxation, Interfaces between the polymers and etc. Thin polymer films have numerous technological applications in various industrial and biomedical sectors related to protective and functional coatings, non-fouling biosurfaces, biocompatibility of medical implants, separations, advanced membranes, microfluidics, sensors & devices, adhesion, lubrication and friction modification.

REFERENCES

[1] “Bistac, S. & Schultz, J. (1997). Solvent retention in solution-cast films of PMMA: study by dielectric spectroscopy, Progress in Organic Coatings, 31, 347-350, 0300-9440/97/$. Bistac, S. & Schultz, J. (1997). Study of solution-cast films of PMMA by dielectric spectroscopy: Influence of the nature of the solvent on α and β relaxations, Int. J. Adhesion and Adhesives, 17, 197-201, 0143-7496/97/$17.00. “

[2] “De Paoli, M. and Gazotti, W. (2002). Electrochemistry, Polymers and Opto-Electronics Devices: Acombination with a Future. J. Braz. Chem. Soc., Vol. 13, No. 4, 410-424, 0103-5053. “

[3] Lee, K. H., Lee, K., Suk Oh, M., Choi, J., Im, S., Jang, S., Kim, E. (2009). “Flexible high mobility pentacene transistor with high-k/low-k double polymer dielectric layer operating at _5 V. Organic Electronics”, 10, 194–198. 1566-1199/$.