Appendix-I

Properties of polymers

1. Teflon AF

Teflon AF 1600 is an amorphous fluoropolymer and a registered product from DuPont (USA). The material is similar to other amorphous polymers and is soluble in selected Perfluoro-compound such as FC 40. The highly uniform thin films can be prepared using spin-coating or dip-coating technique. The structure of Teflon AF is as shown in figure 1. It is also known by the name of Poly[4,5-difluoro-2,2-bis(trifluoromethyl)-1,3-dioxole-co-tetrafluoroethylene].

![Chemical structure of Teflon AF 1600.](image)

Figure 1: Chemical structure of Teflon AF 1600.

It is chemically inert hence it is used for the coating where chemical resistance as well as the ability to withstand high temperatures (≤ 300 °C) is important. The optical transparency of 1 µm thick Teflon AF is > 95 % ranging from UV to IR hence it also useful in coating for optical devices. The typical molding temperatures range is from 240°C to 275°C. The typical water contact angle on the film is ~ 110° and the critical surface energy is 15.7 dyne cm⁻¹. The dielectric constant of Teflon AF is ~ 1.93. The breakdown field of Teflon AF 1600 is 200 V/µm. Due to these excellent properties the polymer is extensively used in electrowetting based experiments and device fabrication.

2. Polystyrene (PS)

Polystyrene is one of the most widely used polymers. Polystyrene combines different properties that make it suitable for different applications. Polystyrene is used in microfluidic devices and biological culture plates. Polystyrene is extensively used...
in daily life. The typical applications consist of disposable plastic cutlery, dinnerware and plastic model assembly kits. The structure of polystyrene is shown in figure 2. Polystyrene is soluble in many solvents such as benzene, toluene, xylene, and ethylbenzene at room temperature. Thin films can be formed very easily using suitable deposition technique such as dip-coating, spin-coating etc. The transparency of polystyrene is 80-90% to visible radiation. The surface energy is found to be 41 dyne cm\(^{-1}\). The breakdown field of polystyrene is \(>100\ \text{V}\mu\text{m}^{-1}\). Polystyrene is a hydrophobic polymer having water contact angle of \(\sim 95^\circ\). The dielectric constant of polystyrene is 2.5.\(^7\)

![Figure 2: Chemical structure of polystyrene.](image)

3. Poly(methyl methacrylate) [PMMA]

PMMA is another polymer which is extensively used in many applications. This polymer can be cut and join very easily by dissolving the plastic at that point. It possesses very nice properties such as high light transmission (> 92%), good resistance to UV lightening and weathering, extremely high surface hardness and good resistance to chemicals.\(^8\) It is very good option for glass because of light weight and high surface hardness. The chemical structure of PMMA is shown in figure 3.

![Figure 3: Chemical structure of PMMA.](image)

The surface energy of PMMA is 41 dyne cm\(^{-1}\). The contact angle value on the thin film is found to be 82°. The glass transition temperature is 105 °C. The breakdown field of PMMA is \(>100\ \text{V}\mu\text{m}^{-1}\) and the dielectric constant is 2.6.\(^7\)
4. Poly(vinylidene fluoride-hexafluoropropylene) [PVDF-HFP]

PVDF-HFP is a copolymer that shows ferroelectric properties. PVDF-HFP is a semi-crystalline polymer. The amorphous domains especially consisted of HFP segments while the crystalline regions consisted of VDF segments. The copolymer has been shown to be a promising matrix for an electrolyte material in modern lithium ion batteries. The chemical structure of PVDF-HFP is shown in figure 4. The polymer is soluble in the solvents like acetone, dimethylacetamide, dimethylformamide, etc.

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\begin{array}{c}
\text{CH}_2 - \text{CF}_2 \underbrace{\text{CF}_2}_{m} \underbrace{\text{CF}}_{n} \underbrace{\text{CF}_3}_{\text{CF}_3}
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\textit{Figure 3: Chemical structure of PVDF-HFP.}

The thin film of PVDF-HFP possesses water contact angle of 110°. The glass transition temperature is -62°C and the dielectric constant is ~10.
References