POLYMER BLENDS

A polyblend or polymer blend is any physical mixture of two or more different polymers or copolymers that are not linked by covalent bonds having better properties than individual component polymer.

Preparation of Polymer Blends! - following methods can be used!-

a - For amorphous and semicrystalline polymers, mixing of polymers is done at temp above Tg or Tm resp. This mixing gives mechanical Blends.

b - Polymers are dissolved in common solvents & then solvent is removed, it gives Solution-cast Blends.

c - Fine dispersion of polymers in water (latex) are mixed & then mixed polymers are coagulated, it gives latex Blends.

d - Cross-linked polymer is swollen with different monomer, then monomer is polymerised & cross-linked. It gives Inter-Penetrating Polymer Networks (IPN) or chemical blends.

For making a blend of polymers, it is essential that they are compatible with each other i.e. both the polymers should be friendly in structure.

Ex:- (i) Two hydrocarbon polymers are blended (polyethylene + polypropylene)

(ii) Wool (polyamide) + Terylene (polyester) as they have 'O' atoms & similar structural parts (COO- & -CONH)

(iii) Cellulose nitrate & polyglycols are possible to blend.

(iv) Polyester + cotton (cellulose fibre) can be blended.

Classification of Polymer Blends! - (a) classification can be on the basis of preparation of Polyblends :- Mechanical Blends, Chemical Blends, Latex Blends and Solution-cast Blends.

(b) or on the basis of compatibility :-

Miscible Blends	Immiscible Blends
→ Usually clear	→ Usually opaque
→ Exhibit a single glass transition temp (Tg) intermediate b/w those of individual components. (no phase separation under stress)	→ Exhibit seperate Tgs characteristics of each component. (show phase separation under stress)

Tg - temp. at which an amorphous solid becomes soft upon heating or brittle upon cooling. The G.T. temp. is lower than M.P. of its crystalline form, if it has one.)

Properties of Polymer blends :-

→ A polymer blend, components appear as seperate phases when viewed under microscope.
→ B/w polymeric chains, only vander waals forces, dipole-dipole interactions or H-bonding exist.
→ Properties of a polymer blend are closely related to the properties of individual components.
→ A polymer blend can be synergistic for any property (i.e better than the weighted average) or Non-synergistic because of : unfavourable dipole-dipole attractions or disruption of such attractions between components resp.

Advantages :-

→ Blending usually improves properties like processesability, impact strength, abrasion resistance etc.
→ Degradation of sensitive polymers can be protected by blending e.g. PMMA is degraded by gamma radiations but when it blends with styrene-acrylonitrile copolymer, the rate of degradation reduces.
→ Polyester (high tensile strength, crease resistant, durable but does not absorb sweat easily & gets heated by sunlight) is blended with cotton to make it cooler.

Examples :-

→ Blend of natural rubber & synthetic compatible rubber: Natural rubber → weak, too much elastic, water absorbing, & tacky / Butadiene rubber → provides better properties with faulty properties minimized.

Examples :- ABS Acrylonitride Styrene rubber + Butadiene Styrene Rubber (used in automobile parts, reflectors, name plates & other such things where reflecting surface is required.

PC-ABS (Polycarbonate-ABS) → used in electrical housing & machine parts.
(Homopolymer + copolymer)

Nylon-6-PC :- for making sports equipments & transport containers.
(Homopolymer + Homopolymer)

Effect of blending

Mechanical / physical properties of homogeneous polymer blends can be predicted using the following semi-empirical relationship :-

$$P = P_1 V_1 + P_2 V_2 + I V_1 V_2$$

$P \rightarrow$ particular property
$V \rightarrow$ volume fraction in the mixture,
$I \rightarrow$ interaction term (may be +ve, -ve or zero)

When $I = 0$

$$P = P_1 V_1 + P_2 V_2$$

i.e - Properties are strictly additive

When I = +ve (positive term)

$$P = P_1 V_1 + P_2 V_2 + I V_1 V_2$$

The property in this case is better than the weighted average, and the blend is said to be synergistic for that property. Results in very favourable dipole-dipole attraction b/w polymer components.

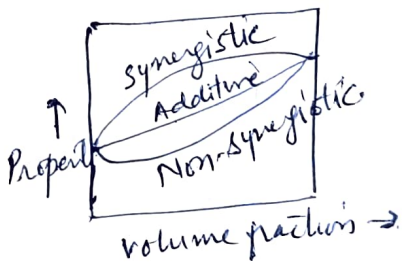
When I = -ve (Negative term)

$$P = P_1 V_1 + P_2 V_2 - I V_1 V_2$$

The property is worse than the weighted average (Non-synergistic).

Graph for property Vs volume fraction

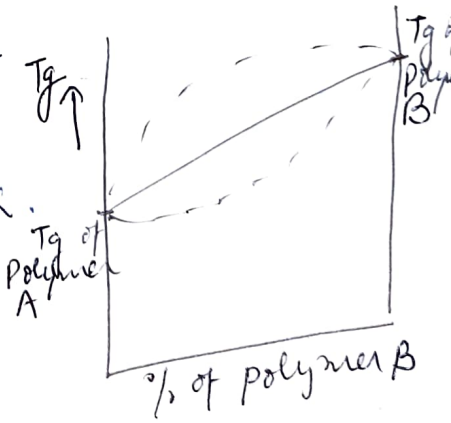
Non-synergism arise when a favourable intermolecular interaction is disrupted.



⇒ The Tg's of miscible blends can be calculated using simple rule of mixtures equation -

$$Tg = w_1 Tg_1 + w_2 Tg_2$$

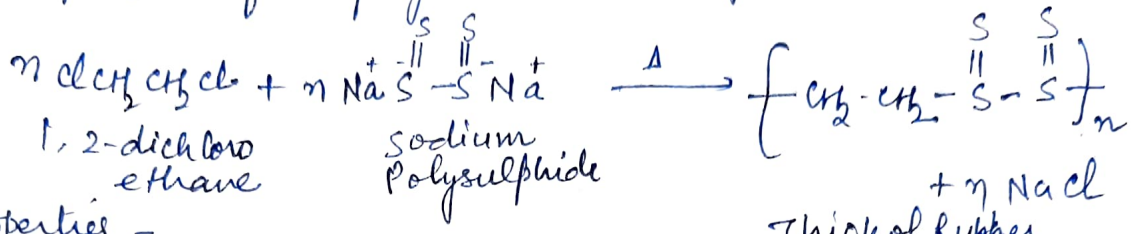
$w \rightarrow$ wt fraction, $Tg \rightarrow$ in K.



Rubbers

Thiokols (T) Polysulphides or Polythio-ethers –

Preparation :- They are typically ~~the~~ liquid polymers that can be crosslinked by converting the terminal thiol groups (–SH) of the polymer to disulphide (–S–S–) links.



1, 2-dichloro ethane — Sodium Polysulphide — Thiokol Rubber

Properties –

→ Typical temp. range = –45°C – 105°C.

→ The elastomer has a high sulphur content, approximately 80% by wt, making it a high density material with a high ~~density material~~ resistance to swelling by hydrocarbon oils.

→ The low stability of the sulphur–sulphur bond on the other hand, causes a strong tendency to relax & flow under pressure.

Applications : ① The polymer is most used as a ~~low~~ low molecular wt. liquid that cures in place to form an elastomeric sealant.

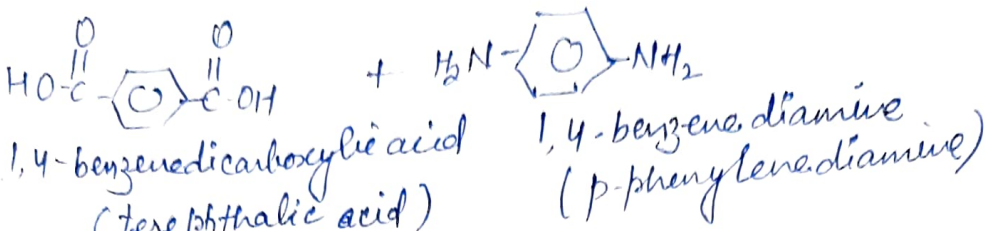
② Primarily used in oil-resistant & weather-resistant seals and gaskets.

③ Also used in gasoline hoses & other applications.

Rubbers

Kevlar (Poly(p-phenylene terephthalamide))

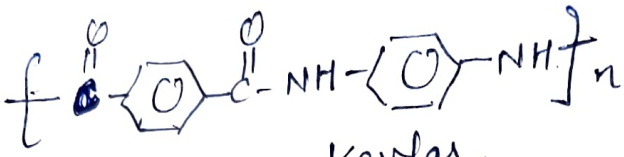
Preparation -



1,4-benzenedicarboxylic acid (terephthalic acid) + 1,4-benzenediamine (p-phenylenediamine)

Copolymer
Condensation polymer

↓ Polymerisation



Kevlar

Properties -

→ Benzene rings are linked to the amide linkage; therefore, Kevlar is a very rigid polymer.

→ As it is an aromatic polyamide, it is also known as Aramide polymer.

→ Stronger intermolecular H-bonding (with neighbouring chains) makes it exceptionally strong having extraordinary mechanical properties.

→ Kevlar has ability to be spun into fibres having 5-times the tensile strength of steel.

Applications: (a) for making Tyres, brakes, clutch lining & other car parts
(b) Bullet proof vests
(c) Safety helmets
(d) Aerospace & aircraft industries.