**Polymer Process Engineering**

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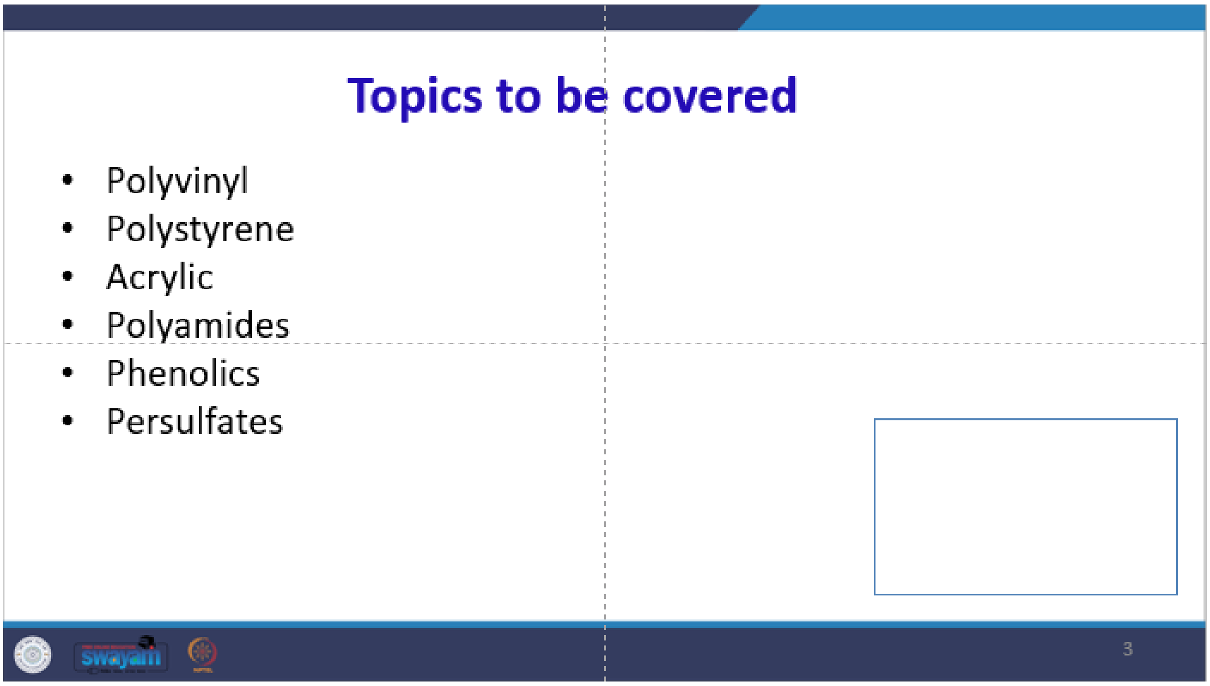
**Lecture- 51**

# Polymer Materials in Electronics

Hello friends, welcome to the Polymeric Materials in the Electronics segment. of Polymer Process Engineering. Now, here is a look that what topics we have covered previously, we discussed about the fluorocarbons apart from this we discussed about polyesters we discussed about polyvinyl, and all these subjects are covered under the definition types, different types of properties, synthesis, and applications. So, we covered all these things in the previous segment. In this particular segment, we are going to cover polyvinyl, polystyrene, acrylic, boronimides, phenolics, persulfates, etc. All these play a very vital role in the synthesis of polymers as well as we are polymers and they are very widely used in electronic applications.




So, let us start with the polyvinyl. The polyvinyl this refers to a group of polymers derived from the vinyl monomer, primarily vinyl chloride and this is the structure that is CH2 double bond CHCl. This double bond attracts the further polymerization process of this particular monomer and they are widely used in different type of applications like in electronic industry due to their you can say the desirable properties or due to their properties or inherent properties which can be widely used in the electronics application. And they are classified as vinyl polymers and this can be further modified or you can say the copolymerize with other monomers to enhance the specific properties which is desired for different type of electronic applications.

## Polyvinyl: General Information

- Polyvinyls refer to a group of polymers derived from vinyl monomers, primarily vinyl chloride ($CH_2$=CHCl).
- They are widely used in various applications, including the electronics industry, due to their desirable properties.
- They are classified as vinyl polymers and can be further modified or copolymerized with other monomers to enhance specific properties.

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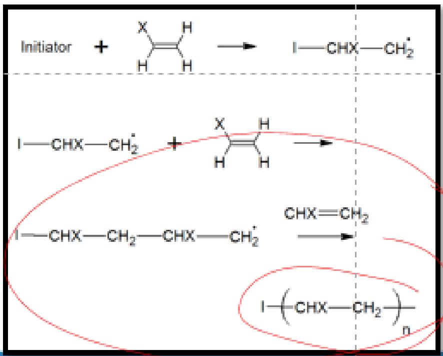
Now through polymerization, these vinyl chloride monomers undergo a chemical reaction. These are known as the vinyl polymerization. This results in the formation of a long chain of repeating units and they are linked together. So, you see here that this is the vinyl polyvinyl or vinyl. Now when we talk about the properties if we go for end use then definitely we have to look into the different types of properties.

## Polyvinyl: General Information

- Through polymerization, the vinyl chloride monomers undergo a chemical reaction known as vinyl polymerization, resulting in the formation of long chains of repeating vinyl units linked together.

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So, first property that is in which attracts them that is electrical insulation. They have the good electrical insulation properties making them suitable for applications where electrical conductivity needs to be minimized. Then another property which is attracts that is the thermal stability and these polymers exhibit good thermal stability which allows them to withstand over a wide range of operating temperature and sometimes you need a different type of a temperature or sometimes elevated temperature. So obvious reason is that the things which are made of should not go on degradation. So that is why if a large range of temperature will be there then the things will not be get degraded.

## Polyvinyl: Properties

- **Electrical Insulation:** Polyvinyls have good electrical insulation properties, making them suitable for applications where electrical conductivity needs to be minimized.
- **Thermal Stability:** These polymers exhibit good thermal stability, allowing them to withstand a wide range of operating temperatures without significant degradation.
- **Chemical Resistance:** Polyvinyls show resistance to many chemicals, including acids, alkalis, and solvents, making them suitable for environments where exposure to various substances is expected.

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Then the chemical resistance, the polyvinyl shows the resistance to many chemicals like acid, alkali, solvent and this makes them suitable for environment where the exposure to the various substances is expected. Then apart from this the mechanical strength play a very vital role. So, this depends on the specific polyvinyl formulation and processing and these polymers or polyvinyl can offer a good mechanical strength and durability. Versatility, this can be easily modified or copolymerized with other monomers or functional groups to tailor their properties and sometimes you may enhance the flexibility, impact resistance or flame retardancy. Now when we talk about their uses in electronics, the first and foremost use is insulation.

## Polyvinyl: Uses in Electronics

- **Insulation:** They are used as insulation materials for wires, cables, and electronic components to protect against electrical conductivity and provide electrical insulation.
- **Encapsulation:** Polyvinyls are used for encapsulating electronic devices and circuits to provide protection against moisture, dust, and environmental contaminants.
- **Adhesive Films:** Certain polyvinyl formulations can be used as adhesive films for bonding electronic components and substrates.

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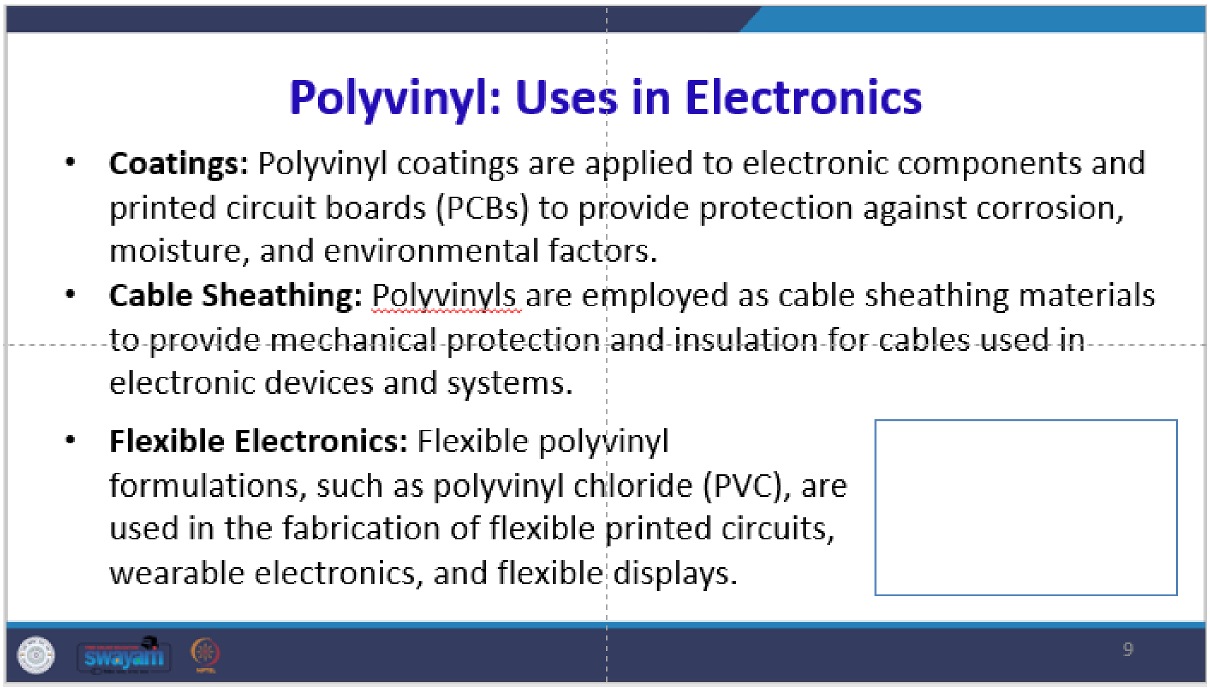
They are used as insulation material for wires, cables, and electronic components to protect against electrical conductivity and provide electrical insulation. Then encapsulation, the polyvinyls are used to encapsulate the various electronic device circuits to provide protection against moisture, dust, and environmental contaminants. So, they create a barrier so that exposure to these components with respect to moisture, dust, and environmental contaminants can be avoided. Then adhesive films, there is the certain polyvinyl formulation, that can be used as an adhesive for bonding electronic components and substrates. Coating, these polyvinyl coatings are applied for the various electronic components and PCBs to provide protection against corrosion.




Cable shedding, these polyvinyl they are employed as a cable shedding material to provide the mechanical protection and insulation for the cables used in electronic devices and system. Flexible electronics are attracting more and more impetus nowadays. So, flexible polyvinyl formulations like polyvinyl chloride, are used in the fabrication of flexible PCBs, wearable electronics, and flexible displays. So, they are the future polymers. Now, let us talk about their classification.

## Polyvinyl: Classifications

- Primary vinyls are formed directly from the polymerization of vinyl monomers, while secondary vinyls are formed by subsequent reactions with reagents that alter the polymer chain groups.
- Polyvinyl acetate is an example of a primary vinyl, which can undergo hydrolysis to form hydroxyl groups that can react with aldehydes to yield acetal derivatives.
- Three important derivatives of polyvinyl acetate in the electronics industry are polyvinyl formal (Formvar), polyvinyl acetal, and polyvinyl butyral.

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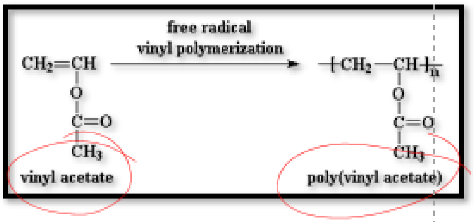
Now primary vinyls they are formed from the polymerization of vinyl monomer while secondary vinyls they are formed by the subsequent reaction with a reagent that alter the polymer chain groups. Now polyvinyl acetate, PVA, this is an example of the primary vinyl which can undergo because the presence of the double bond which can undergo the hydrolysis to form the hydroxyl group and that can react with aldehydes to yield the acetal derivatives. Three important derivatives of polyvinyl acetate in the electronic industry, they are polyvinyl formal, polyvinyl acetal and polyvinyl butyral. Now polyvinyl formals and polyvinyl acetal they are commonly used as a tough and high temperature resistant wire enamels. Acrylic polyethylenes and polypropylene they are also considered a part of the vinyl classification although they are often discussed separately due to the significant commercial importance.

## Polyvinyl: Classifications

- Polyvinyl formals and polyvinyl acetal are commonly used as tough and high-temperature-resistant wire enamels.
- Acrylics, polyethylenes, and polypropylenes are also considered part of the vinyl classification, although they are often discussed separately due to their significant commercial importance.

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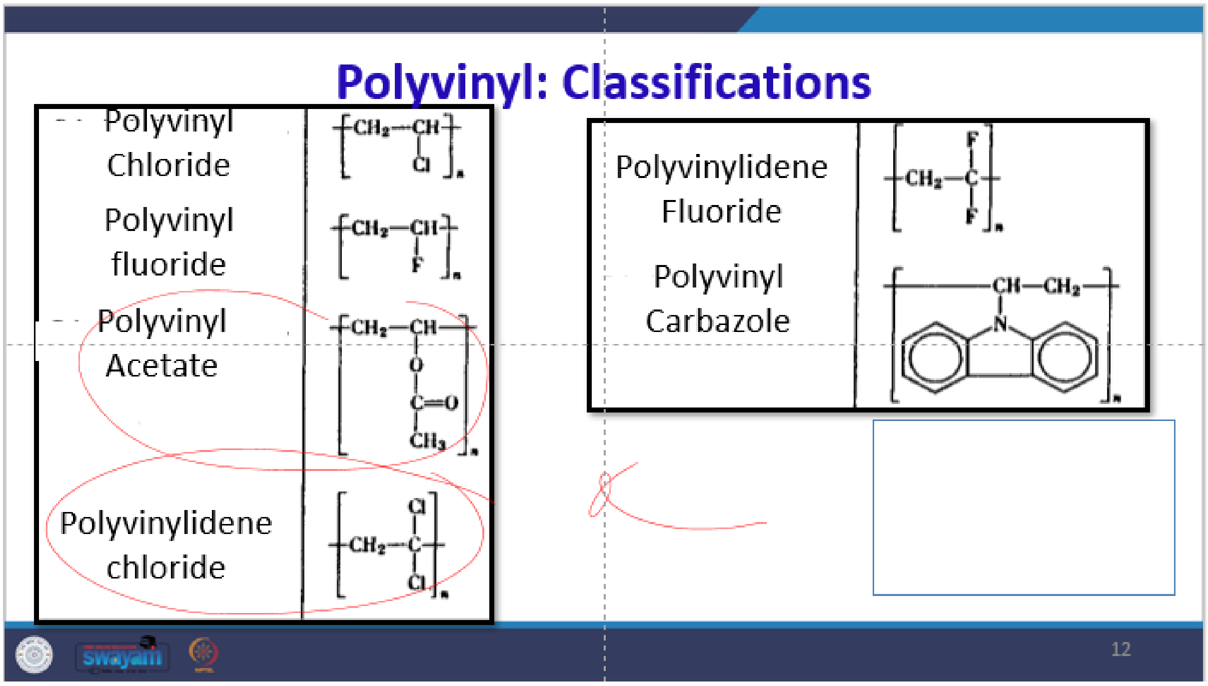
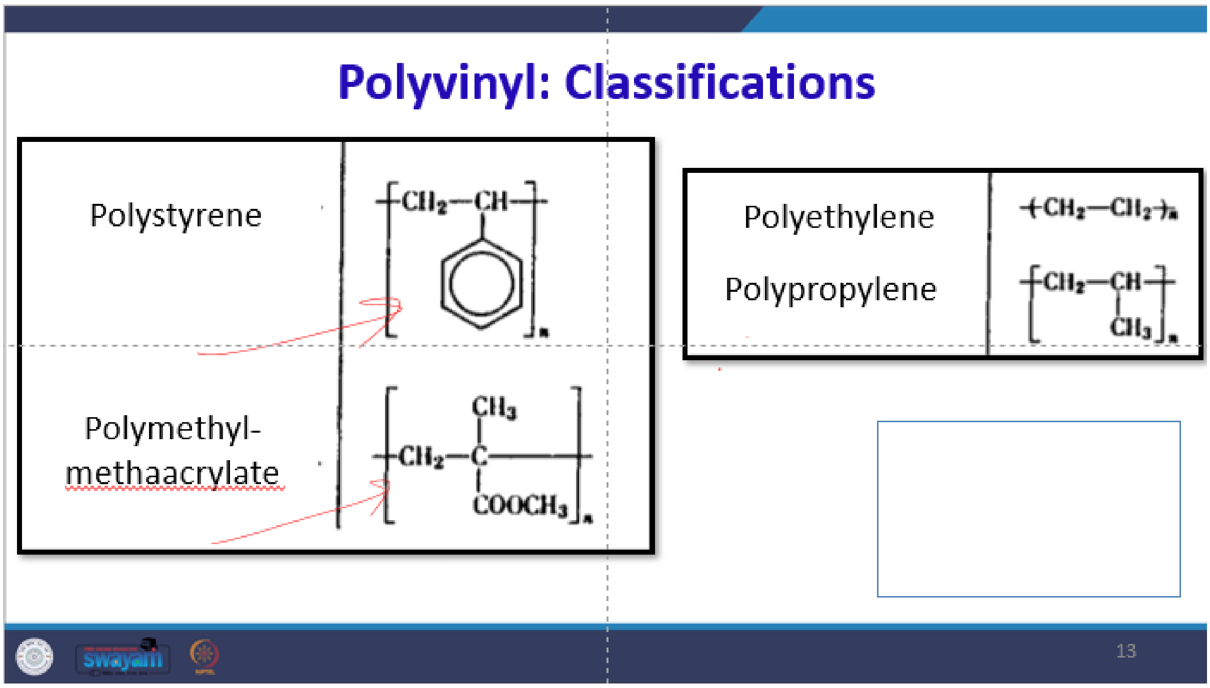



So here you can see the free radical vinyl polymerization. So, vinyl acetate gives you polyvinyl acetate. Here you see that another polyvinyl, the fluorine polyvinyl carboxyl and polyvinyl chloride, polyvinyl acetate all these things are classified. Here you see the polystyrene, this is the classical formula of polystyrene, poly methyl methacrylate they find a very wide range of application, polyethylene, polypropylene and this is the polyvinyl acetate. And if you see that hydrolyzed polyvinyl acetate, see the structure.



## Polyvinyl: Classifications

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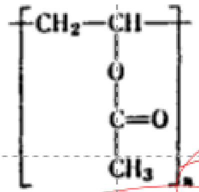
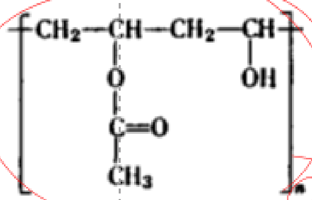
| Polyvinyl Acetate |  |
| Hydrolyzed Polyvinyl Acetate |  |

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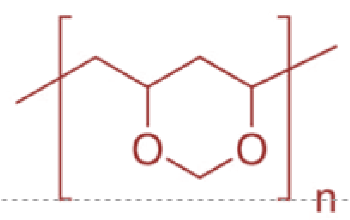
This represents the number of chains. Now here you see this is the polyvinyl alcohol PVA and this which we are talking about the polyvinyl formals and polyvinyl butyral. So, all these things you can see that the structural difference.

## Polyvinyl Formals

Polyvinyl formals find various applications in the electronics industry due to their desirable properties. Here are some uses and details about their electrical properties:

- **Magnetic wire Insulation:** Polyvinyl formal coatings are applied to magnet wires used in transformers, motors, and other electrical equipment. They provide insulation and enhance the wire's dielectric strength.



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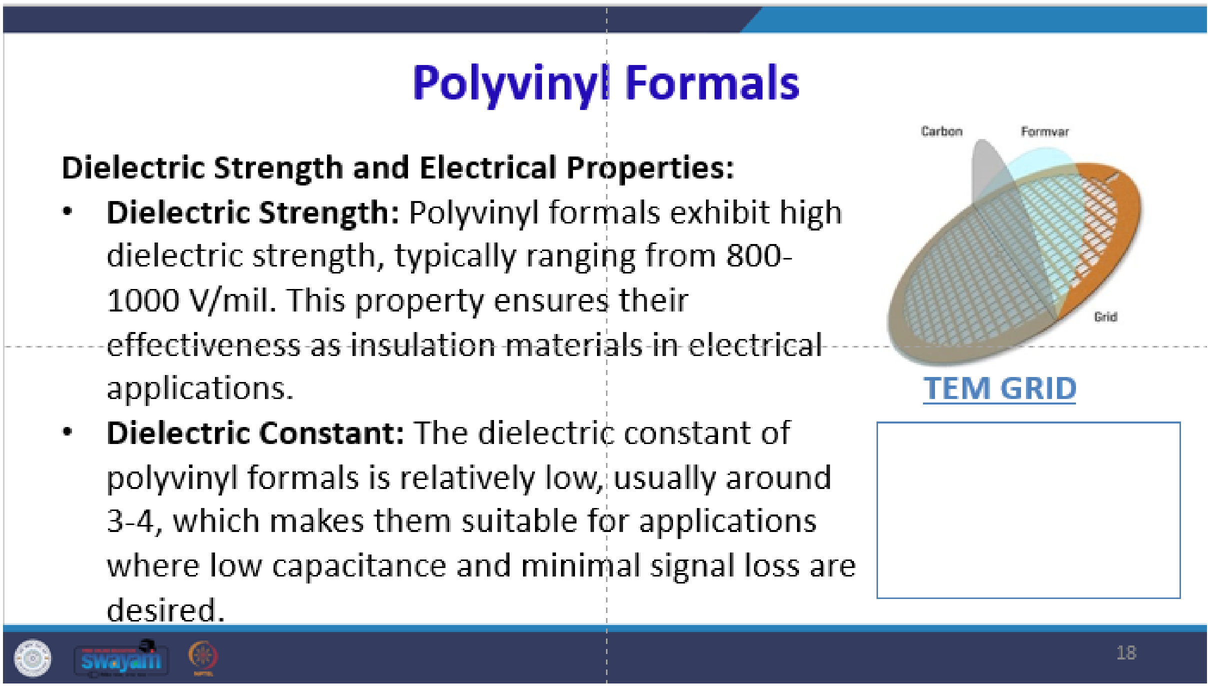
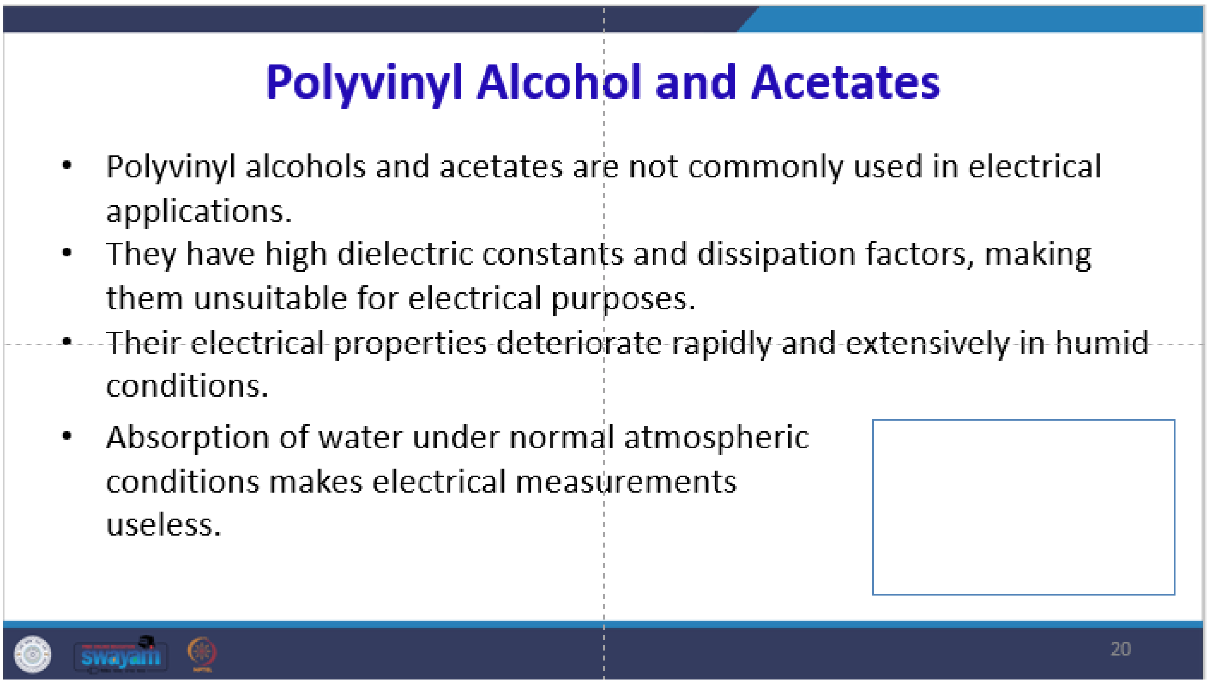
Now polyvinyl formals, find various applications in the electronic industry due to their desirable properties. Now we have enlisted some of the desired properties with respect to the electrical properties like magnetic wire insulation, and the polyvinyl formal coating they are applied to magnet wires used in the transformers, motors, and other electrical equipment and they provide insulation and enhance the wire's dielectric strength.

Coil coatings are utilized as a protective coating for electronic coils and transformers. Then electrical tapes, the polyvinyl formals can be employed in the production of electrical tapes for insulation purposes. Then film capacitors, are utilized as dielectric material in the film capacitors. Now, dielectric strength and electrical properties are in question. So, let us talk about in detail about this dielectric strength.

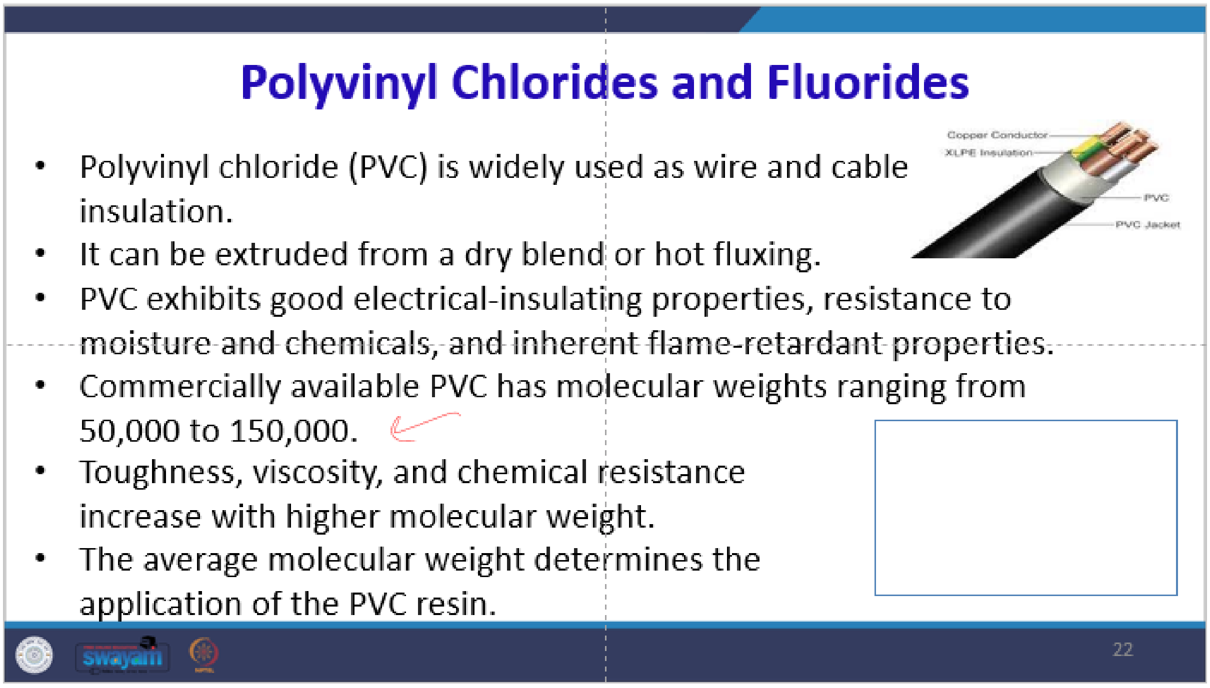



Now this polyvinyl formal exhibit high dielectric strength typically ranging from 800 to 1000 volt per mil and this property ensures their effectiveness as insulation material in the electrical application. Now when we talk about the dielectric constant, the dielectric constant of this polyvinyl formal is relatively low and usually around 3 to 4 which makes them suitable for application where low capacitance and minimal signal losses are desired. Insulation resistance, these are polyvinyl formals they offer excellent insulation resistance preventing leakage of electric current and ensuring the reliable performance in electronic devices. Insulation factor, this factor of polyvinyl formal is generally low and indicating the minimal energy loss as heat during electrical operation. The temperature stability, they exhibit good thermal stability maintaining their electrical properties over a wide temperature range.

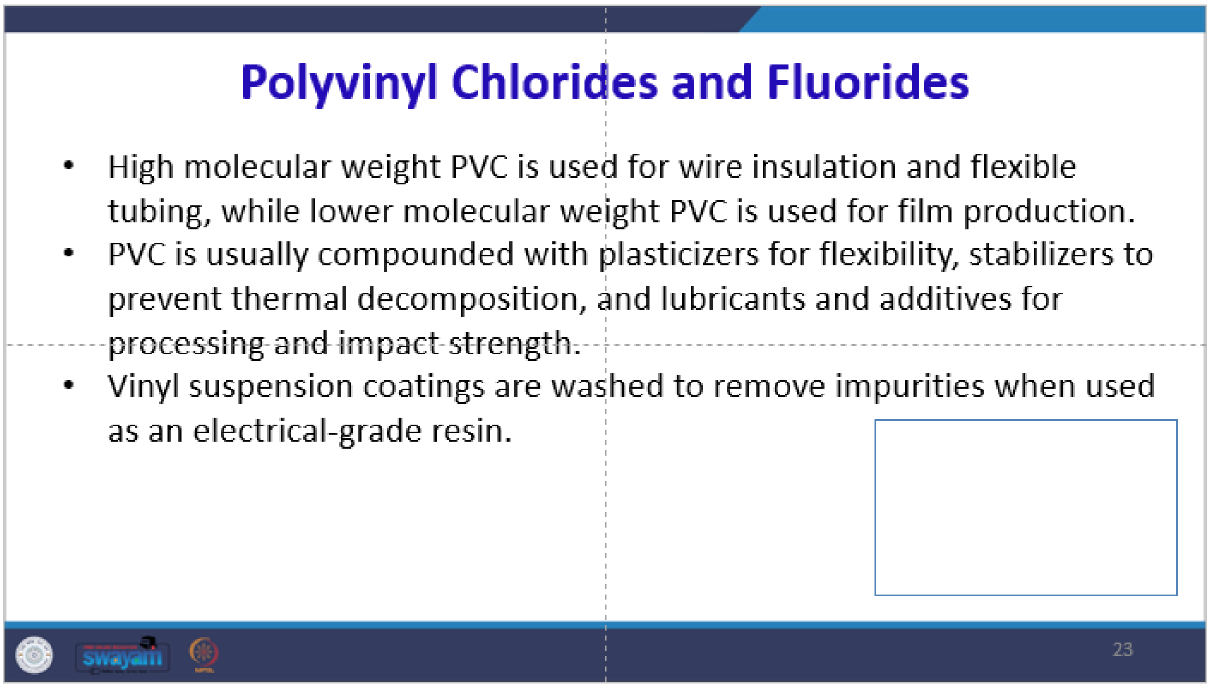



Now let us talk about the PVA or polyvinyl alcohol and acetates. The polyvinyl alcohol and acetates are not commonly used in electrical application. They have high dielectric constant dissipation factor, this makes them unsuitable for electrical purposes. Their electrical properties deteriorate rapidly and extensively in humid condition and absorption of water under normal atmospheric condition makes the electrical measurement useless. And also, they exhibit the poor thermal stability above 95 degree Celsius in the presence of air.

The PVA, they are occasionally used as a temporary coating for masking or as a acid indicator. They can be easily removed by dissolving in warm or hot water because they are having very close affinity with the water. And generally, these resins find greater use in non-electrical applications like paper coating, packaging films and house paints. Let us talk about the polyvinyl chloride and fluorides, PVC and PVF. Now PVCs, they are widely used as wire and cable insulating material.

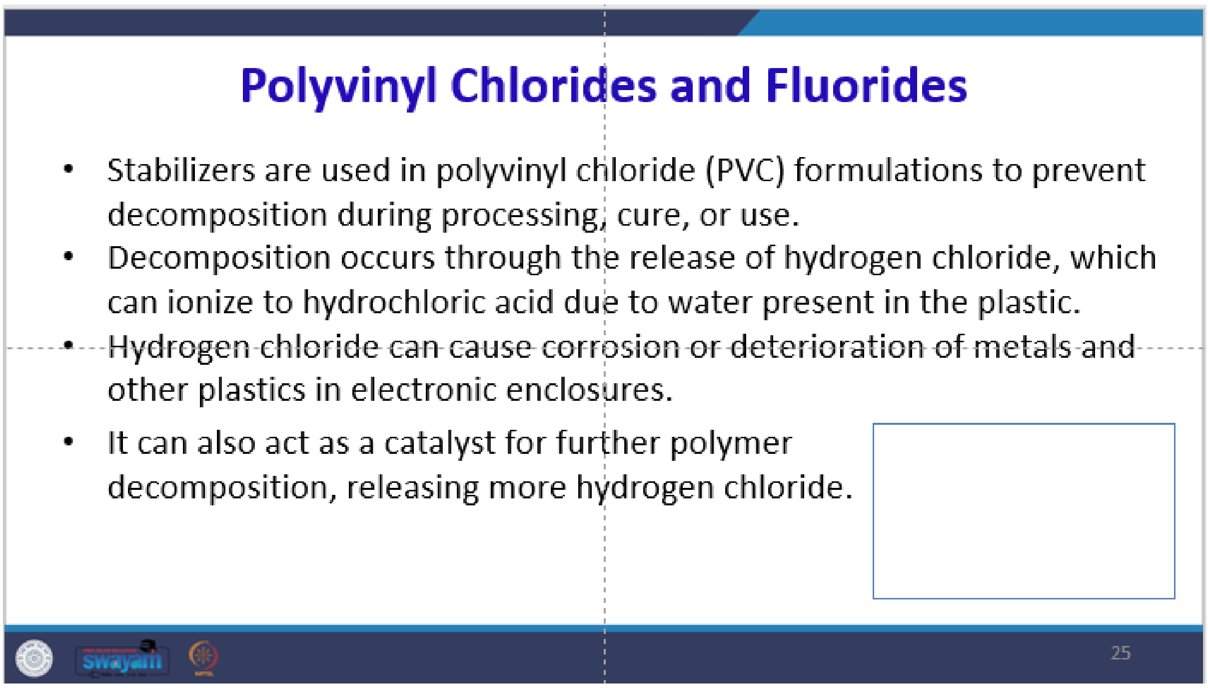



It can be extruded from a dry blend or hot fluxing. This PVC exhibits good electrical insulating properties, and you will find all these PVC particles in your domestic affairs where the teeth wire is coated with the PVC coating for the insulation purpose. So, this gives an idea of how versatile and how useful these polyvinyl chlorides are. And they resist the moisture, chemicals, and inherent flame retardancy. Now the commercially available PVC, has a molecular weight ranging from 50,000 to 1,50,000.




Toughness, viscosity, and chemical resistance increase with high molecular weight. We have already discussed this in some of the chapters. The average molecular weight determines the application and the property of the PVC resin. The high molecular weight PVC is used for wire insulation and flexible application or flexible tubing like water hosing, etc. You will find that all these are made of PVC.

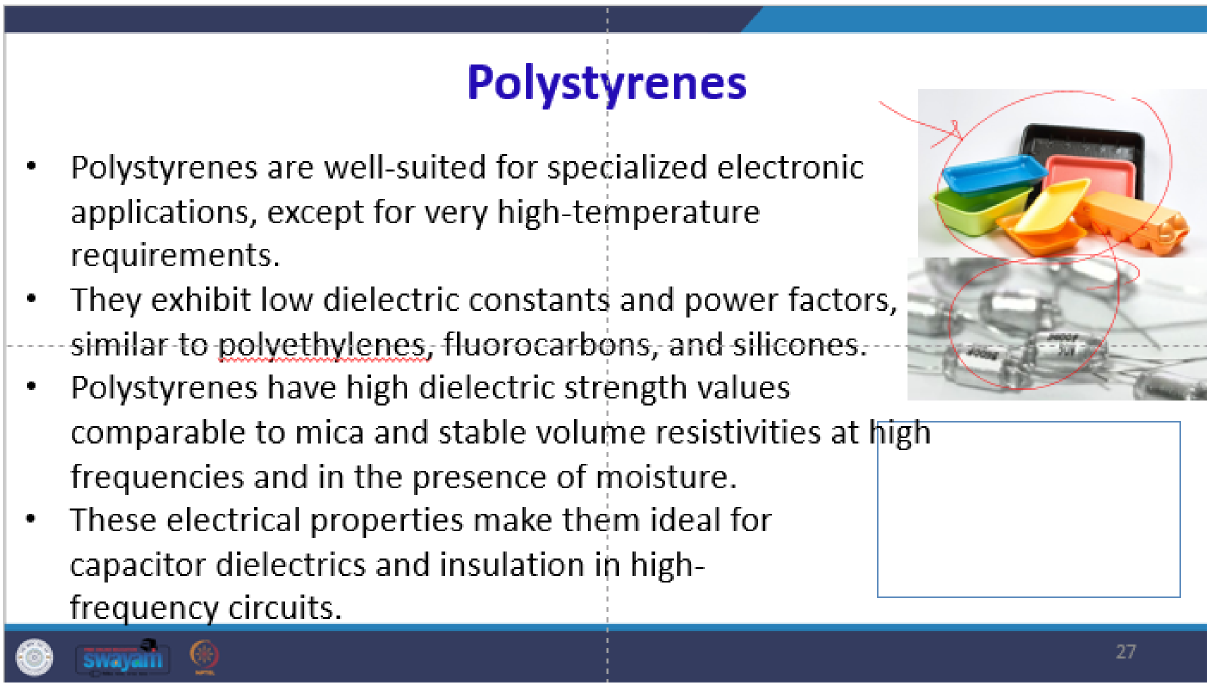
The lower molecular weight PVC is used for film production. Now PVC is usually compounded with plasticizers for flexibility because sometimes they are stiff and if you compare with the electrical insulators with the garden hose, then you will see that our garden hoses are more flexible. That is because of the presence of the plasticizers. They are low molecular weight solvents, and when they are embedded in a polymer matrix, they provide flexibility. Now they need some stabilizers to prevent the thermal decomposition because sometimes all these things may be exposed to higher temperatures like electrical wires or garden hoses etc.




And also, some lubricant and additives for processing and impact assistance. Now, the vinyl suspension coating is washed to remove the impurities when used as an electrical resin. Now, usually, when we talk about plasticizers, careful selection is needed to minimize the degradation of electrical properties and moisture absorption. Because these are low molecular weight solvents and because this provides flexibility to the system. But simultaneously, there, I mean there are a wide range of solvents available as of date.

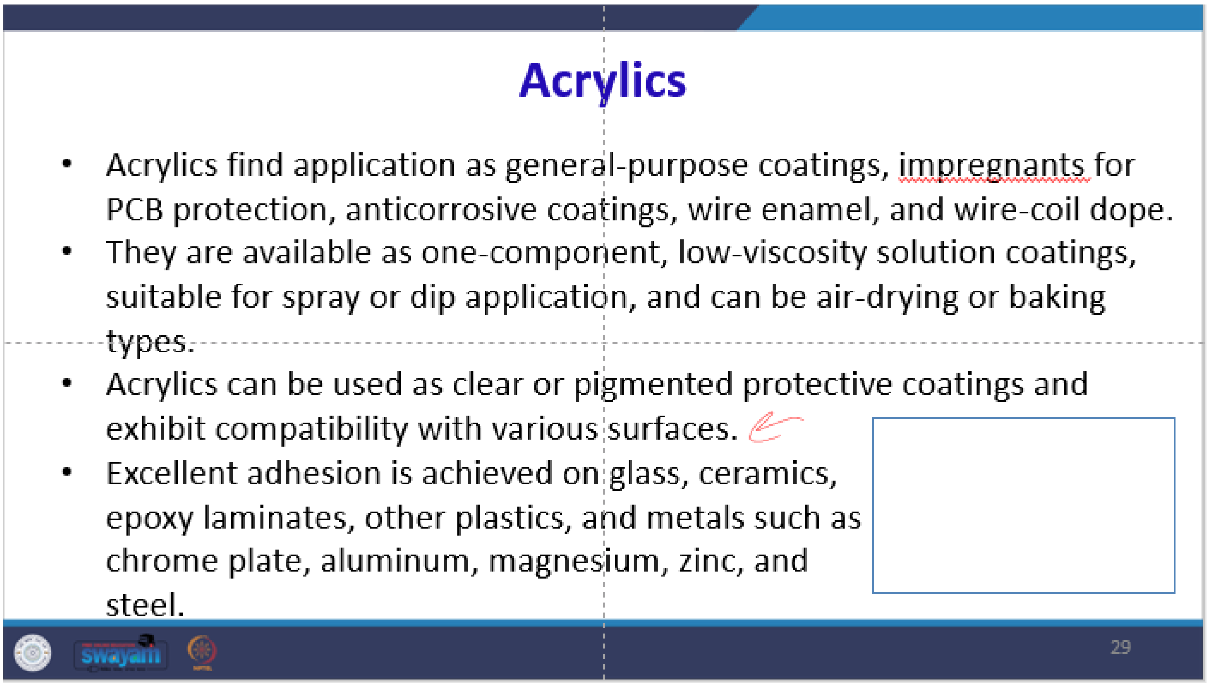
But we need to look that if we are using for the garden hose, then the solvent or a plasticizer must be different as compared to when we are using as electrical insulation. Now fillers like clay or calcium carbonate can be added to reduce the cost and improve the electrical resistivity. There is a large number of fillers that can negatively impact mechanical properties like abrasion resistance, tensile strength, elongation, and flexibility. Now stabilizers, they are used in the PVC formulation to prevent decomposition during the processing, cure or use. Now, this decomposition occurs through the release of hydrogen chloride, which can ionize to hydrochloric acid due to the water present in the plastic.

This HCl or hydrogen chloride can cause the corrosion or deterioration of the metal and other plastic in the electronic enclosure. So, it can also act as a catalyst for further polymer decomposition and releasing more and more hydrogen chloride. So environmental issues are also play a very vital role. Now acceleration of this particular process can occur at high temperatures under the high humidity and the presence of certain metals like iron, zinc, maybe say around 150 to 160 degree Celsius. Now, these stabilizers react with and remove the trace amount of hydrogen chloride, preventing catalytic degradation of the polymer chain.

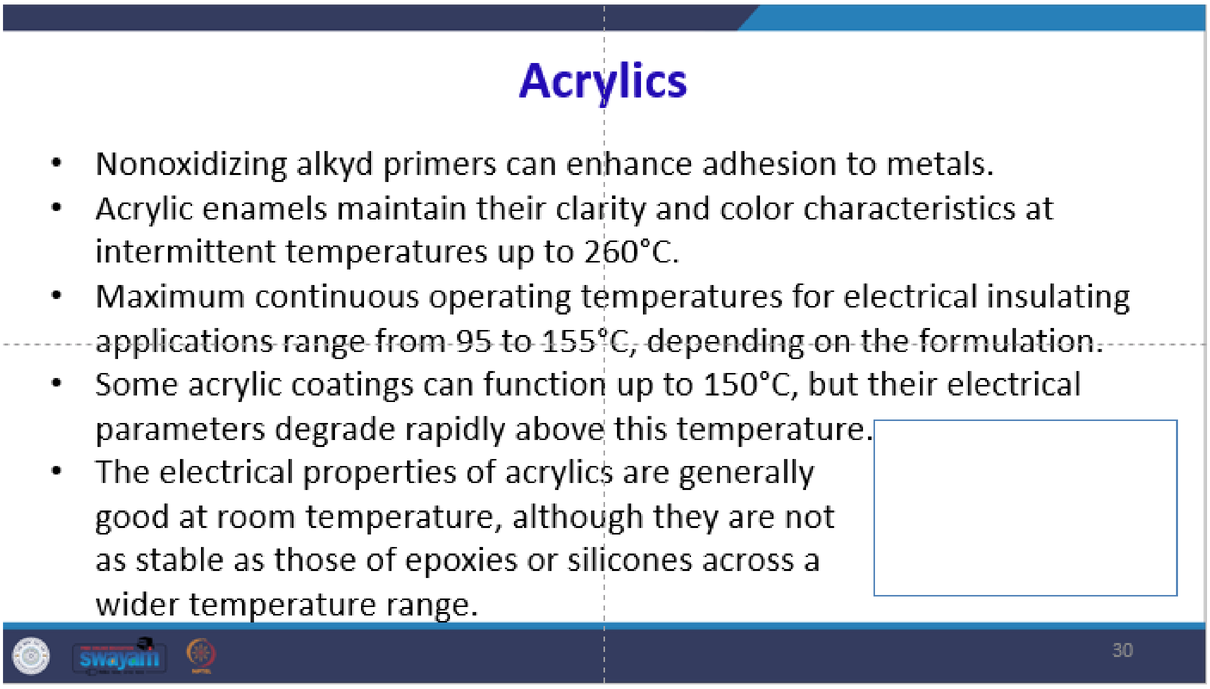



Some of examples of stabilizer includes lead, epoxide compounds, and plasticized urea for mead hydrasins. Now let us talk about polystyrene. Now these polystyrenes they have found their wide application in such kind of utensils and other applications. So, they are well suited for specialized electronic applications and except for very high-temperature requirement. So, if you are having a moderate temperature requirement, you can use these polystyrenes and they exhibit low dielectric constant and power factors similar to polyethylene, fluorocarbons and silicones and they have high dielectric strength values comparable to mica and stable volume resistivity at high frequencies in the presence of moisture.

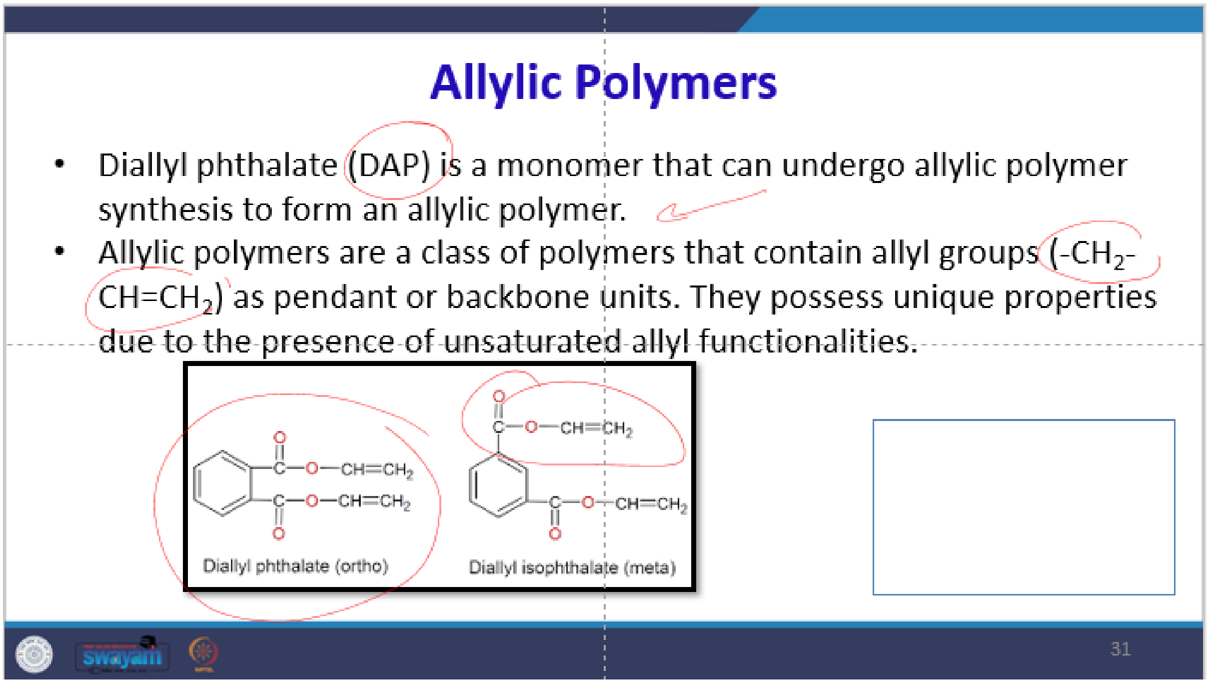
Now these electrical properties make them ideal for the capacitor dielectrics and insulation at in high frequency circuit. Now they are transparent, clear, capable of transmitting large chunk of light and with a good refractive index property and they are used in coating lenses and other optical equipment due to their transparency. And they offer a very wide range of color for decorative purposes due to their excellent tinting and coloring properties. But simultaneously they have some limitations like inherent flammability and a lower and upper temperature limit to of say 85 degree Celsius which may not be suitable for various you can say the specific electronic applications.



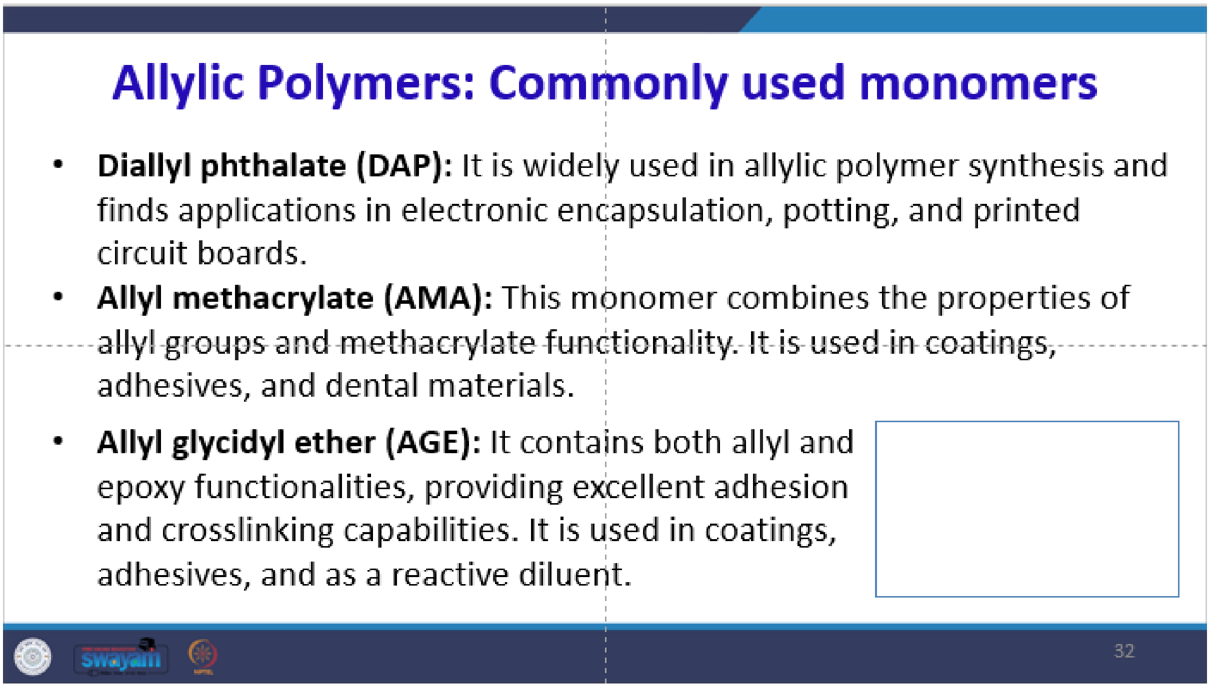

Let us talk about acrylics. Now acrylics are defined application as a general-purpose coating, impregnants for PCB protections, anti-corrosive coatings, wire enamels, and wire coil dope and they are available as one component low viscosity solution coating suitable for spray or dip application and can be air dried or a baked. These acrylics can be used as a clear or pigmented protective coating and exhibit compatibility with various different types of surfaces. Now excellent adhesion is achieved on glass, ceramics, epoxy laminates, and other plastics and metals such as chrome plate, aluminum, magnesium, zinc, and steel. Even oxidizing alkyd primers can enhance the adhesion to metal. Now, acrylic enamel maintains its clarity and color characteristics at intermittent temperatures say up to 260 degrees Celsius.



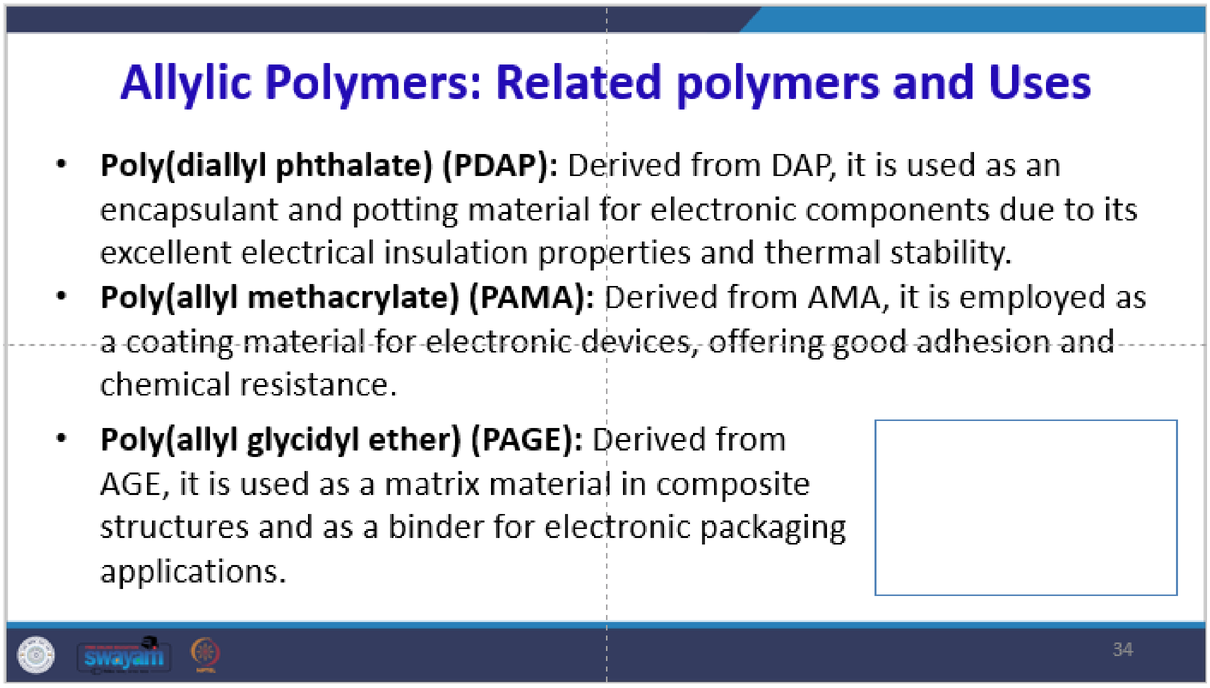

So, the maximum continuous operating temperature for electrical insulation, this can be ranges from 95 to 155 degrees Celsius depending upon the formulation. Sometimes filler, sometimes stabilizers, all these may alter all these temperature ranges. Some electrical coating, they can function up to say 150 degrees Celsius, but the electrical parameters degrade rapidly above this particular temperature, and some sort of degradation may occur in situ the electrical properties of acrylics are generally good at room temperature, although they are not stable as those of epoxies or silicones across wide temperature range. Now let us talk about alkalic polymers.




Dialyl thalate DAP is a monomer that can undergo alkalic polymerization to form the the the allylic polymers. Now these allylic polymers they are class of polymers that contains allyl group that is CH2, CH, CH2 as a pendant or backbone unit. Now they possess unique properties due to the presence of unsaturated allyl functionalities. Here you see that this is dialyl thalate ortho position and here you see that dialyl isothalate in beta position. Now allylic polymers they are commonly used they are commonly used monomers and dialyl thalate is widely used in allylic polymer synthesis and find application in electronic encapsulation, potting and printed circuit boards. Allyl methacrylates AMA this monomer combines the properties of allyl group and methacrylate functionality and it is used in coating adhesives and dental materials.




Allylglycidal ethers it contains both allyl and epoxy functionalities providing excellent adhesion and cross-linking capabilities and it is used in coating adhesive and as a reactive diluent. Allyl acrylate AA it combines allyl and acrylic functionalities offering good adhesion and flexibility and it finds application in coating adhesive and sealants. Allyl cyanate ethers it possesses both allyl and cyanate ether groups providing high thermal stability and low dielectric properties. It is used in high temperature application like printed circuit board and microelectronics. Now let us talk about some related polymers and their uses like polydilyl thalate PDAP this derived from DAP which we discussed earlier and it is used as an encapsulant and potting material for electronic components due to its excellent electrical insulation properties and thermal stability.




Then polylilyl methacrylate PAMA this derived from AMA and it is employed as a coating material for electronic devices and they offer good adhesion and chemical resistance. Then polylilylglycite ether page this derived from the age and it is used as a matrix material in composite structure and as a binder for electronic packaging application. Then polylilyl acrylate PAA this is derived from the allyl acrylate and it is used as a flexible coating material for electronic circuits providing good adhesion and mechanical properties. Then polylilylcynate ester this is again derived from allylcynate ester and it is employed in high temperature electronic application like aerospace defense because of its excellent thermal stability and low dielectric constant.

## Polyamides

- Polyamide resins have repeating amide groups along the polymer chain.
- They are formed through the condensation of di- or polyamines with dibasic or polybasic acids.
- Polyamides can be classified into three main types: thermosetting fatty acid polyamines, thermoplastic fatty acid diamines, and nylons.
- Thermosetting polyamides, derived from dimerized fatty acids and trifunctional amines, are widely used as coatings.

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Let us talk about the polyamides. Now polyamide resins they have repeating amide group along the polymer chain and they formed through the condensation of dye or polyamines with a dibasic and or polybasic acid. Now these polyamides can be classified into 3 main types thermosetting fatty acid polyamides, thermoplastic fatty acid, diamines and nylons. Now thermosetting polyamides, they derived from dimerized fatty acid and trifunctional amines and they are widely used as a coating. Now diethylyl triamine reacts with the dimer acid a mixture of dicarboxylic and polycarboxylic acid from linoleic acid and this produces a series of liquid resins and these resins can be used as a coating themselves or commonly co-reacted with epoxies. Now the high concentration of amino groups in polyamide facilities the opening of epoxy ring and cross linking with multiple molecules.

Now epoxy polyamide coating they exhibit enhanced adhesion and increased flexibility, improved surface wetting and better corrosion and chemical resistance compared to the standalone epoxies or polyamides. Now the polyamide resin they can react with the phenolic and other resins this results the highly cross-linked thermosetting coating. Now thermoplastic polyamides they are formed by condensing dimerized fatty acid with a short chain diamine such as ethylidene diamine. Now these thermoplastic polyamides they are soluble in many solvents and compatible with the different type of plasticizers and resins and they can be formulated as solution coating, aqueous dispersions or hot melt coating. So, both thermosetting and thermoplastic polyamides they can be applied using spray dip or brush technique and thermoplastic polyamides can also be applied using fluidized bed electrostatic spray or hot melt method.

## Polyamides: Properties

- Some polyamide resins have softening temperatures of 110 to 200°C and hot-melt temperatures of 190 to 250°C.
- Coatings derived from these resins have abrasion resistance better than polyethylene but not as good as polyurethane and epoxy coatings.
- Polyamide coatings formulated with zinc yellow, red lead, or other pigments exhibit excellent corrosion-inhibiting properties.

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Nylon although the part of polyamide family they have a different structure compared to other polyamides and they are composed of a linear molecule formed by the condensation of aliphatic diamines with aliphatic dicarboxylic acid. There are certain properties attributed to the polyamides like some polyamide resins they have softening temperatures of say 110 to 200 degree Celsius and hot melt temperature of say 190 to 250 degree Celsius and the coating derived from these resins have abrasion resistance better than polyethylene but not as good as polyurethane and epoxy coating. The polyamide coating formulated with the zinc, yellow or red lead or other pigments exhibit excellent corrosion inhibition properties. The extensive studies some people they have carried out extensive studies on the corrosion inhibiting efficiency of the polyamide primers and epoxy polyamide coating with detailed data on the steel protection from salt water because it is very important for the coastal areas and then hydrochloric acid for industrial application then hydrogen sulphide for various kind of the refining applications. Now alkyd or oil-based coating showed the least resistance to long term exposure to salt water.

While polyvinyl chloride coating performed better, epoxy polyamide demonstrated the highest resistance. The polyamide coating, they are not widely used as an insulation in the electronic application or electrical equipment due to their marginal electrical properties especially in the presence of moisture and they have high water absorption compared to the other polymer types. Different ranges being studied so far for different type of water absorbing capacity. Now polyamide epoxy combinations they are commonly used as a coating for electronic adhesive compound filling compound for the component vibration, damping and encapsulation.

# Phenolics

- Phenolic resins, developed in 1909 by L. H. Baekeland, are the oldest completely synthetic polymers.
- They are formed by the chemical reaction of phenols with aldehydes using an acid or base catalyst.
- The most commonly used resin is based on the condensation of phenol and formaldehyde.
- Phenolic resins can exist in liquid or solid form depending on their structure.

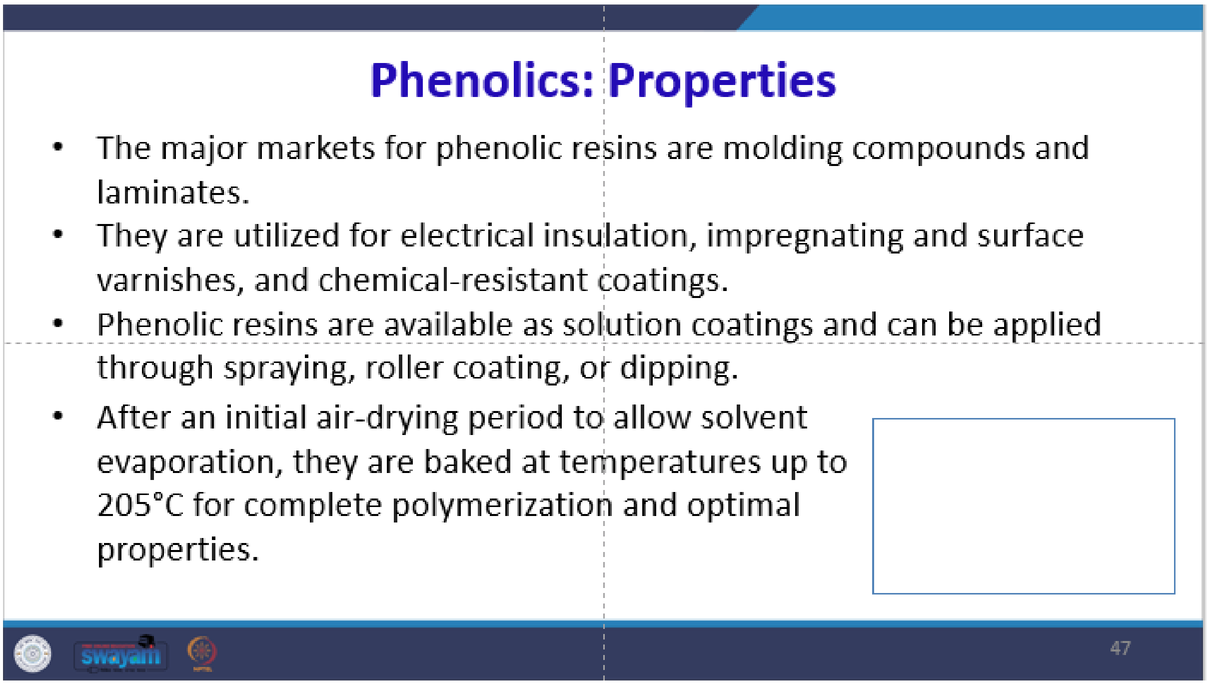


Now let us talk about the phenolics. The phenolic resin it was first developed by Baker Land in 1909, and they are the oldest completely synthetic polymers they are formulated and they are formed by the chemical reaction of phenol with aldehydes using an acid or base catalyst. The most commonly used resin is based on condensation of phenol and formaldehyde and phenolic resin can exist in liquid or a solid form depending on their structure. The hardening and or curing this is achieved by the heating of the resin alone with either alone or with hexamethylene tetramine which acts as a catalyst and a source of methylene group. Now this particular curing process this is a very essential process in any kind of polymerization process. This curing process leads to the crosslinking of the resin molecules opposite to the hydroxyl group and the phenolic varnishes they are prepared from substituted phenols such as paraffinol or paratertiary butyl derivatives by reacting them with tunglincite or other oils.

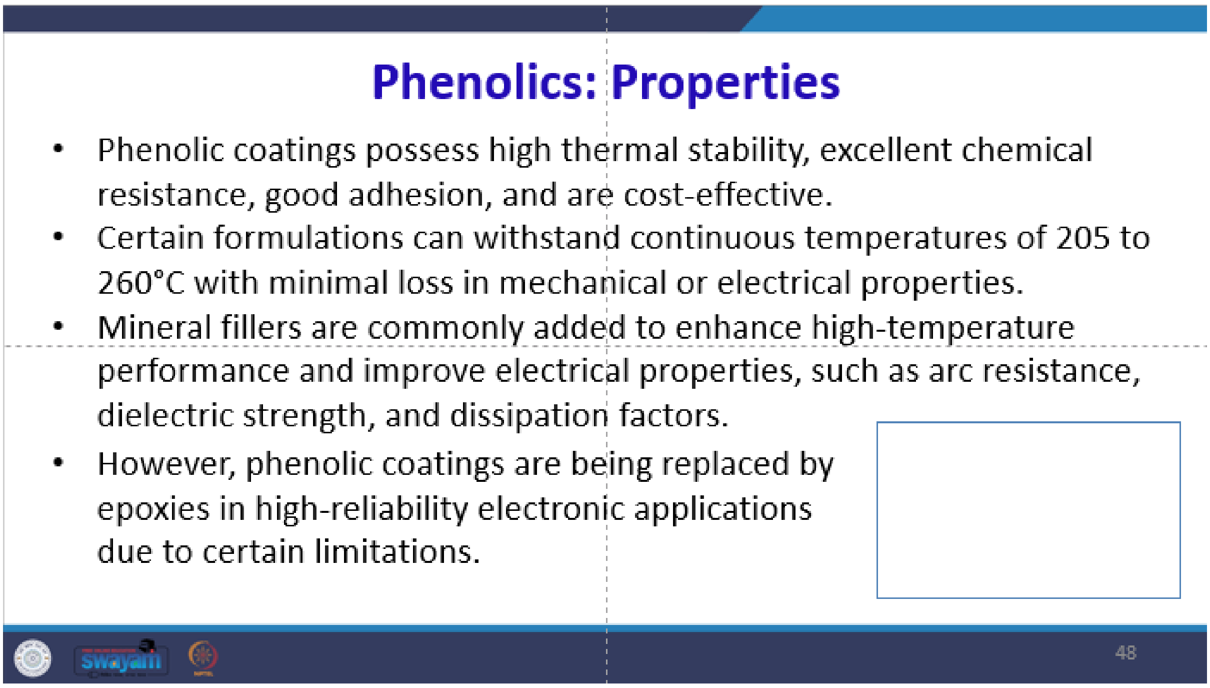
# Phenolics

- Hardening or curing is achieved by heating the resin alone or with hexamethylenetetramine, which acts as a catalyst and source of methylene groups.
- This curing process leads to cross-linking of the resin molecules opposite the hydroxyl groups.
- Phenolic varnishes are prepared from substituted phenols, such as p-phenyl or p-tertiary butyl derivatives, by reacting them with tung, linseed, or other oils.
- Although these varnishes can be air dried, baking is recommended for optimal chemical and environmental resistance.

Now these varnishes can be air dried because the atmospheric moisture plus air can react so that can be air dried. Baking is recommended usually for the optical chemicals and environmental resistance. Now when we consider the properties the major market for these phenolic resins they are the moulding compounds and laminates and they are utilized for the electrical insulation in piginating and the surface varnishes and the chemical resistant coating. These phenolic resins are available as a solution coating and can be applied through spraying, roller coating or dipping. So, after an initial air-drying period to allow solvent evaporation they are baked at temperature up to say 205 to 210 degree Celsius for complete polymerization and optimal properties.

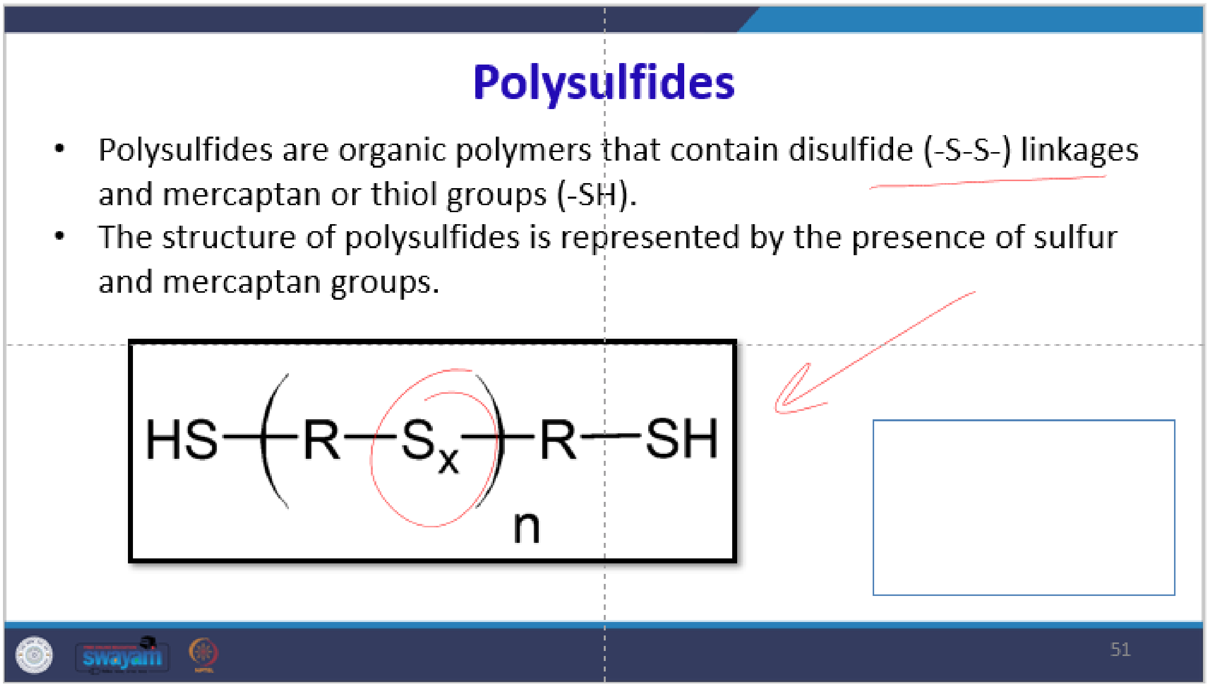



Now these phenolic coating possesses high thermal stability, excellent chemical resistance and good adhesion and they are cost effective.

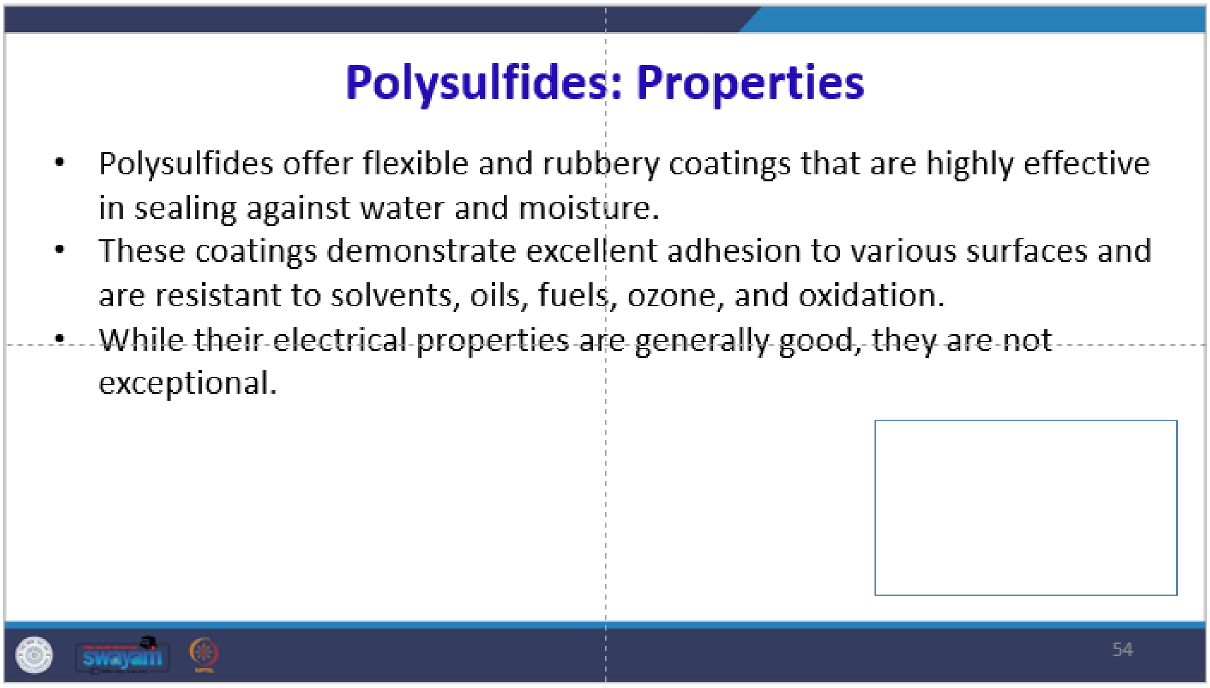


Certain formulations can withstand continues at a temperature of, say, 205 to 260 degrees Celsius with a minimum loss in mechanical or electrical properties. So, mineral filters or mineral fillers they are commonly added to enhance the high-temperature performance and improve the electrical properties like arc resistance, dielectric strength, and dissipation factors. Now, phenolic coatings are being replaced by epoxies in high-reliability electronic applications due to certain limitations and they can cause the corrosion of metal like copper due to the acidic or alkaline nature of the catalyst used in the curing process. Phenolic exhibits above-average shrinkage leading to the high stress and moisture released during the cure can be trapped within the coating degrading its electrical properties.

Compared to epoxies phenolics generally have poorer electrical properties due to their highly polar nature this results in a high dielectric constant and dissipation factor. The high curing temperature sometimes requires the phenolics to make them unsuitable for the temperature-sensitive electronic component and some of these limitations can be overcome by co-reacting phenolics with other reasons, making them more suitable for electronic and electrical applications. Let us talk about the polysulfides. Now the polysulfides are the organic polymers that contain the sulphur linkage and mercaptan or thiol groups. The structure of polysulfide is represented by the presence of sulfur and mercaptans groups.

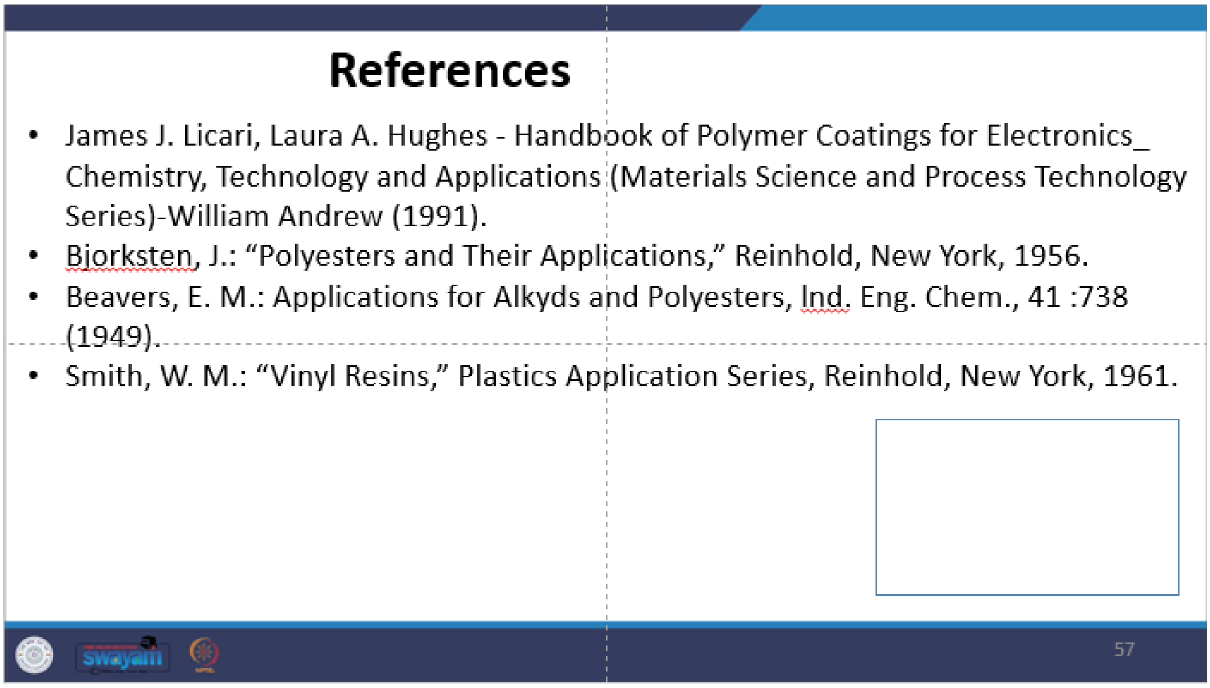



Now liquid polysulfides the molecular weight ranging from 3000 to 4000 can be further polymerized to form the solid rubbery coating using oxidative free radical mechanism. Now to achieve the polymerization a second component or curing agent need to be added to the polysulfide resin and commonly used curing agent is includes the dicumene, hydroperoxide, lead dioxide, manganese dioxide, calcium dioxide, zinc dioxide all these are the peroxides. Now polysulfide resins they have the ability to co-cure with the various polymers resulting in elastomeric and plastic properties based on the ratio of the ingredient used. Like epoxy resin they combined with aliphatic or aromatic amines and they are commonly co-cured with polysulfides. Let us talk about the properties the polysulfide offers of a flexible and rubbery coating and they are highly effective in sealing against water and moisture, and these coatings demonstrate excellent addition to various surfaces and are resistant to the solvent, oil, fuel, ozone, oxygen, etc.




And their electrical properties are generally good. They are not exceptional. The polysulfide has a relatively high dielectric constant, typically around seven or greater than 7. The electrical insulation resistance of polysulfide can decrease rapidly and irreversibly when exposed to humidity and applied voltage. The choice of curing agent can influence the electrical properties of polysulfide. Red dioxide as a curing agent tends to yield better electrical properties compared to cumene hydroperoxide.

Polysulfides find value in low-cost electrical applications such as transformer coating, connectors, potting, and sealing and they are not commonly used for circuit board protection or microelectronic insulation. So, applying a voltage potential across the polysulfide-coated conductor pattern in humid conditions leads to a decrease in insulation resistance values and decomposition of the polysulfide coating. The electrical properties of polysulfide can be modified by incorporating fillers. So overall, polysulfide exhibits poorer electrical and solvent resistance properties compared to epoxies. So, dear friends in this particular segment we have discussed various polymeric materials that are used in electrical electronics applications.




And for your convenience we have included four references which you can utilize as per your requirements. Thank you very much.