

# A Study of Chemical Equipment's Applications Towards Polymer Best Mechanical Composites Materials

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## Abstract

By its elemental characteristics and by the microstructural arrangement the polymer composite material properties are clearly defined. The utility of the polymeric matrix may be increased, the processability increased or the durability of the composite extended by additives and modifiers. The fibres are primarily responsible for altering performance (strength and stiffness properties). When equivalent strength is attained in all directions, the less structurally demanding situations use the random organisation of fibre into a polymer matrix. In a broad variety of applications, fibre-reinforced polymer materials may be utilised effectively and can enhance substantially the characteristics of chemical protection equipment and promote the creation of new ones with better features.

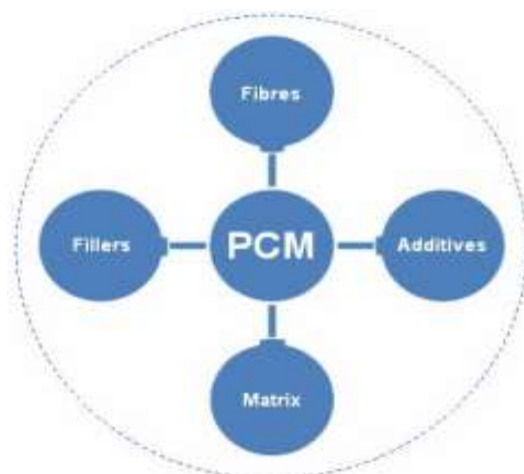
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## 1. INTRODUCTION

There is a lengthy history of chemical weapons. Overall, it is not particularly difficult to produce chemical weapons. The development and use of these weapons have been restricted by international treaties, but there are still nations and terrorists that are trying to acquire them. Protective measures must be implemented to prevent both military and civilian contamination and to minimise the loss of lives in the event of the threat of chemical warfare agents. Another reason for protecting the chemical plant is the possibility of accidents (resulting toxic industrial chemicals, or TICs). Continuous study is thus being carried out to enhance the protective equipment characteristics. We have investigated in this regard the option of utilising novel protective materials as composite polymer materials. Composite materials are composed of two or more materials that have substantially distinct physical and/or chemical properties and that create a material that, when combined, is netly superior than the individual components. In the completed construction, the various components stay independent and distinct. In high-performance goods which are light and robust enough to withstand violent loading conditions, such as racing car bodywork, boat slides, aerospace components, etc., fibre-reinforced compound materials have become well known.

## 2. POLYMER COMPOSITE MATERIALS (PCMS)

The PCMs in question consist of a fibre-reinforced polymer matrix. The polymer matrix is polyurea, with modified nanotubes of carbon and graphene oxide in the considered fibres. In many years, fiber-reinforced polymer materials, mainly in the aerospace and car sectors, have been effectively utilised in a broad variety of applications. PCMs are defined by their component characteristics and the microstructural structure in an unambiguous manner. The polymeric matrix helps to stress transmission and offers microclimate protection, whereas the fibre primarily supports strength and rigidity. Filler is also utilised to enhance performance, giving advantages such as shrinkage management, surface fluidity and fracture strength.



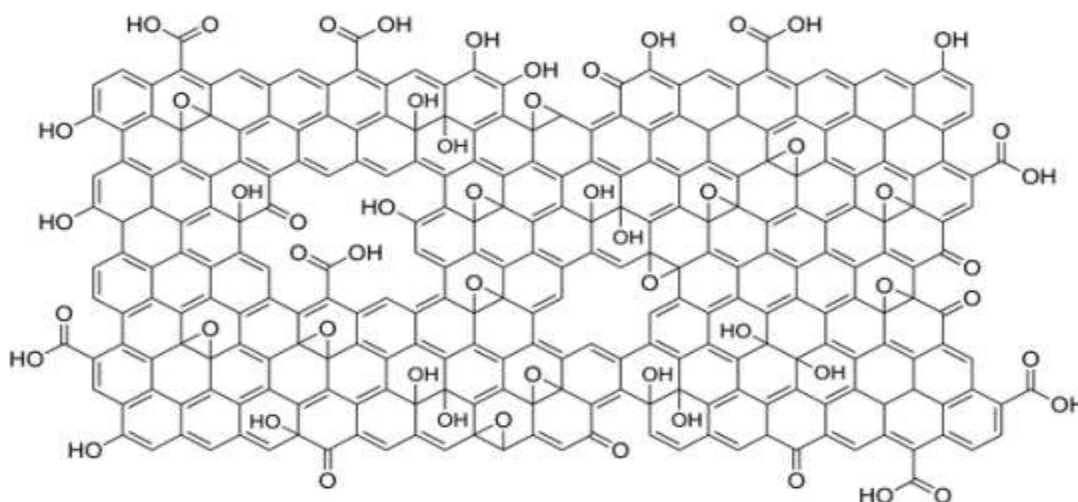
**Figure 1 – PCM components**

Additives and changes The utility of the polymer matrix may be expanded, its processability increased or its composite durability extended (Fig 1). Viscoelastic displacement of a matrix under pressure is used to strengthen the polymer matrix of high strength and modular fibre for loading the body to the fibre, resulting in highly resistant composite material with high modulus. The goal of the combination is to create a two-phase material in which the primary phase, which controls rigidity, is in the form of fibre and is well spread, bind and protect by the polymeric matrix, which is the secondary phase.

### 1. PCMs constituent

Grapheme oxide, functional carbon nanotubes and polyurea are important compounds that were explored for producing PCMs.

Graphene oxide (GO) Different types of polymer and GO nano-composites with significantly better mechanical characteristics have been described during the last few years, which are superior to normal composites. GO as possible reinforcing materials in the production of polymer composite material has thus been attracted greater attention. The single (1-layer) GO plates have an efficient  $207 \text{ GPa} \pm 11\%$  Young modulus, which indicates one of the strongest materials ever tested. Together with its promising characteristics and simplicity of processing, GO-based materials make it an excellent solution to integrate into other functional materials.



**Figure 2 – Model of graphene oxide (GO)**

GO-derived polymer nanocomposites have showed significant improvement in properties such as elastic module, tensile strength, electrical conductance, and thermal stability, even at extremely low GO concentrations (0.3 wt percent). The observed enhancement of polymers' mechanical characteristics is indicated by the excellent mechanical contact between the polymer and low quantities of GO, which enables a better transmission between matrix and fibre. The GO synthesis technique was based on the Hummers process. GO microflocks from graphite microflocks were produced using an oxidative approach with mixed acid medium that provided the highest recovery rate of graphite oxides of approximate size to the original graphite crystals. FT-IR, TGA, XPS, Raman spectroscopy, and SEM were the feature of the synthesised GO.

### **3. THERMOSETTING MATRICES**

They solidify generally at room temperature under the effect of heat and an ingredient called hardener during their execution. The cooking is therefore converted into a chemical alteration consisting of a very strong three-dimensional connection between the molecules. This procedure is irreversible and in most solvents the substance treated is infusible and insoluble (alcohols, ketones and hydrocarbons). They are generally more stiff than thermoplastic, more resistant to cracking and more suited for moulding broad components with short, long or fabricated fibres. Polyester, phenoplasts, epoxy resins, polyurethanes and polyimides are the most often used thermosetting matrices.

#### **1. Polyesters (Polyethylene terephthalate)**

The thermosetting material is polyethylene terephthalate (PET) for different applications, such as one dimensional fibre, two dimensional layer and three dimensional network applications. PET is thermosetting polymer with excellent performance and cheap cost, extensively used as packaging material, thanks to its hardness, abrasion-resistance. The thermo-setting matrices constitute 85 to 95% of the use. The average mechanical and thermal resistance of polyethylene terephthalate is characterised by simplicity of operation (implementation without solvent), the possibility of time stable and fast-implementing materials and clear, colourless (ease of colouring in all shades). The polycondensation reaction of ethylene glycol and terephthalic acid was achieved by polyethylene terephthalate.

#### **2. Phenoplasts**

Thanking to its outstanding fire performance, phenoplasts are thermosetting materials which have various uses. They have average mechanical characteristics, good resistance to temperatures, their solvent application, the potential to produce stable prepregs and unachievable light-shades hue. It is produced via formaldehyde polycondensation on phenol. This reaction may be performed in an acid media or in a fundamental medium.

#### **3. Epoxy resins**

Epoxy resins are thermosetting polymers which have to be subjected to severe mechanical and thermal stresses for the production of components. Epoxy resins are distinguished by high mechanical and thermal strength, superior to polyester, feasible implementation without solvents, good chemical resistance, low immersion in humidity and great adherence to fibres and metals. Bisphenol A diglycidyl ether (DGEBA) was produced with epichlorohydrins in the presence of a base by the condensing reaction of bisphenol A.

#### **4. Polyurethane**

Polyurethanes (PU) are part of the thermosetting polymers family that have received increasing attention because of their structural property connections. Ownership of polyurethane with outstanding thermal and adhesive characteristics and also great prospective uses in many sectors, including painting, adhesives, foams, marine antifouling and packaging [94-96]. The polycondensation process involving diisocyanates and mobile hydrogen molecules resulted in Polyurethane (diol or diamine). For example, methylene diphenyl diisocyanate (MDI) and methylene dianiline were produced for polyurethane (MDA).

### **4. CARBON BLACK AND NANOTUBE**

The use of carbon black as a dye, pigment, ultraviolet barrier, antioxidant in the plastics industries has been very long; carbon black increases polyethylene and polyvinyl chloride resistance (PE) (PVC). The thermal conductivity is

increased by composites formed using carbon black as a burden. Furthermore, given its carbon content and the fineness of the particles, electric conduction of charged materials improves. Carbon nanotubes have a particular carbon structure. In the shape of a few of nanometers in diameter, carbons are nanotubes. Carbon nanotubes generate scientific attention because they have remarkable characteristics in many ways. They are both extremely stiff and have very high heat conductivity compared to steel. In addition, single wall nanotubes, from an electrical point of view, have the unique property, that depending on their shape may be either metal or semi-conductive.

### **Metallic charges**

Metallic powders (aluminium, copper and zinc) are introduced in order to make electrical and heat conductive of plastic materials in aircraft and electronics. With metallic polyamides (aluminium or bronze), conductive mouldings that may be covered with metals were produced. Aluminium powdered polypropylene offers outstanding physical characteristics. The strength of the shock, heat and electrical ducts is improved by aluminium. In tool parts, paints, plastics, cold plastic welding, aluminium is utilised. Copper also increases thermal conductivity and electricity. The tools and ornamentation of copper (like bronze). Iron then enhances abrasion resistance. Furthermore, plumbing offers radiation shielding and sound absorption in high-density materials. In pyrotechnical applications, magnesium is also utilised. Edge steel is also used for the usage of tools and zinc increases the resistance to corrosion; it is utilised in protective lacquers.

## **5. ADDITIVE**

Substances which physically are blended with polymers are additives (adyuvants). Additive is designed to change or enhance the polymers' rheological performance or usage characteristics of final materials in a processing machine (physical properties, environmental stability). Organic organometallic additives are often employed in a low-level concentration and with low molecular weight relative to that of the polymer. The major effects, for example plasticizers, Stabilizers, lubricants, dyes and anti-shock agents, are often divided into groups with a principal purpose. Additives are theoretical.

### **1. Lubricants**

Only in the molten state or at temperatures above its glass transition temperature is the formation of thermoplastics feasible. In these circumstances, temperature increases are not adequate to properly decrease viscosity; thus, we need processing aids, like lubricants. A lubricant is capable of exerting outward compatibility with a polymer and of an interior compatibility with a polymer. The volumes of solubility of the polymer and lubricant involved may forecast this compatibility. Two kinds of lubricants are available:

**Outside lubricant:** very little soluble in a polymer that makes the metal surface protective layer. Depending on the metal nature, chemical structure of the lubricant and the polymer involved, this layer is more or less mobile.

**Internal lubricant:** enhances the processing machine's flow of moulded polymer by reducing viscosity. The internal lubricant has a particular function for polyvinyl chloride (PVC). The gelation of PVC cannot be assured, even in the presence of stabilisers, without thermal breakdown by simple heating; homogeneity is achieved through kneading alone to induce the interpenetration of polymer rubbing grain and small particles. The primary lubricants consist of fatty acids and alcohol esters, amides and silicenes, saturated hydrocarbones, polymers, fatty alcohols and acids.

### **2. Plasticizers**

Low or low volatility in a polymer to reduce its relaxing interval simplifies its application and enhances its flexibility or extensibility. Its effect may also reduce the viscosity in the molten stage by decreasing the transition temperature of the glass or by decreasing the elasticity modulus of the plasticized item. The plastic which utilises the most plasticisers of all types is polyvinyl chloride (PVC) (85 percent), with about 35 other plasticisers having the usage of slightly over 10 percent:

- The plastized cellulose esters or ethers with phthalates (particularly low molecular weights) offer them flexibility suitable with the final use of these esters.

- Many thermosetting Resins in which plasticizers (melamines) are employed in processing agents (epoxides, pherolics and polyamides).
- In case of paints in which the plastizing agents simplify their use in the form of films, acrylic such as polymethylmethacrylate (PMMA) or styroenic resins (PS) is required.
- PVCs may be regarded as the most frequent plasticizers since they have an adequate set of necessary characteristics, which can be considered the most common. Alcohol Phtalates
- Epoxides are epoxy derived fatty acids, of which epoxy soy oil, octyl epoxy stearates and epoxy tallates is the most well recognised (salt or ester of tall oil fatty acids, liquid resin obtained as a by-product of paper pulp).
- Aliphatic dicarboxylic acid esters (adipates, sebacates and azelates).
- Polyesters are the result of an aliphatic diacid reaction with diol. diol is an aliphatic. Polyadipates of glycol are the most prevalent, with different molecular weights (from 800 to 10000 g/mol).

Phosphates are often utilised in ancient polyvinyl chloride (PVC) formulations and frequently combine alkyl and/or aryl orthophosphates. The earliest phosphate is tricresyl, although phosphates are usually favoured by diphenyl octyl (or diphenyl isodecyl) because they provide excellent cold results.

### 3. Stabilizers

Large-scale polymers are instable; their instability is manifested in heat, light, and chemical aggressions which change the characteristics of materials, as a result of thermomechanical limitations. They are integrated into additives called stabilisers categorised according to the mechanism of action to avoid or postpone the processes that cause the breakdown of polymers (antioxidants and anti UV agents). In general, synthetic polymers, unlike biopolymers (cellulose and starch), are resistant to microbes. However, the biological assault produces unwanted consequences when coupled with short molecules (plasticizers and lubricants). The resistance to microbial assaults is polymethylene (PMMA), polyethylene (PE) and polyvinyl chloride (PVC). Microorganisms are sensitive for biopolymers, polyamides, natural rubber and highly plasticised PVC, particularly in tropical climate conditions.

### 4. Anti-strokes

There are two types of shock deformation of the plastics, for example, shear flow deformation without decohesion and deformation with crack and fracture development. Shear flow deforms fragile materials mostly. Intermolecular changes occur without density fluctuation. Specific regions known as shear bands are restricted. Stress causes the development of voids in brittle materials that include ripping zones called cracks that may spread and produce breaks. These fractures include polymer fibrils that are directed towards stress application. The blanching of polymers displays them. The fracture is mostly caused by pre-existing surface flaws in both instances. Plastic deformation, such as plasticization of PVC, may be promoted. However, other characteristics, such as the temperature of softening, are changed in this situation. Shock-absorbing additives that distort the distribution of impact energy are utilised to enhance impact resistance without modifying the other features. The resultant strains may be released after a shock on the plastic item and the impact energies can be absorbed by the existence of microvoids and microcavities in the polymer. The strengthening is nevertheless significantly increased by introducing adjuvant nodules that are not particularly compatible with the matrix and the elastic modulus. The fragility of a thermoplasty relies on both the temperature and the pace at which the pressures are applied. The impact effect on the poles of shock-resistant particles is opposites when the module of this strengthening agent is larger than that of the polymer. The respective elastic modules of reinforced polyps and the reinforcement agent (Young Module) and also the diameter of the nodules and the average distance, which is practically consistent to the particle size and state distributed, are the physical parameters governing these phenomenons.

## 6. PCMS AREAS OF APPLICATIONS

The goal beyond modernisation is to produce PCMs with outstanding chemical and mechanical resistance, for applications with commercial potential. For specialist applications of PCMs, different types of reinforcement fibres (hybrid composites) may specifically be utilised for the following: protection of hazardous products from chemicals; external cover for CBRN tents (COLPRO); personal CBRN protection devices, etc. The following may be applied.

## 7. CONCLUSION

Modern military CBRN protection equipment incorporates more effective components of protection. The polymer composite material presented in this paper can dramatically improve existing equipment's protection characteristics and will promote the development of new equipment with better characteristics (lower mass, advanced protection), due to excellent mechanical properties and hazardous chemicals resistance. Alongside the protective properties of PCMs, such features may be developed for the aim of making protective devices in certain forms and sizes.

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