

A Review Article on Acrylic PMMA

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Abstract : In the plastics industry most of the acrylics are the polymers of methyl methacrylate (PMMA). Acrylics can be available in various forms such as molding powder or casting syrups. They are mostly known for the exceptional clarity and optical properties in various fields. Acrylics are mostly used in production of fixtures because of the properties such as slow burning or self-extinguishing. The present paper covers what is acrylic, what are the various uses of acrylic, usage of acrylic in the future technology etc. Possible areas in which acrylic can serve as a useful option are also covered. As we are living in the era of technology and innovation the author in this research paper has tried to focus the advantages of alternative materials in the various fields of technology for prosperity and growth. Different work from other background is also covered in this article.

Keywords : Materials, PMMA, properties, technology, work.

I. INTRODUCTION

1. Introduction

The advancements in the field of technology are constantly taking pace with the help of innovation in several areas. To help support this trend we should consider not only providing effective ways to minimize the cost of the overall production but also having the desired output. During the last few years, it has been seen that researchers are not only focusing to provide new and alternative ways to meet the demand of the consumer but also developing effective substitutes for the survival of the economy. Keeping this in mind the main problem that is faced in most of the development projects is to curb the cost of the production in possible ways such as providing alternative material sources in some areas where work can be carried out without affecting much to the results at the end of the production. The main focus of this research paper is to drive attention towards various other materials that exist and can prove to be much useful in the future generation. Acrylic is often used as a glass substitute but with consideration of its other properties it can be used in a variety of different areas. The most important characteristics of acrylic (PMMA) are its optical clarity, low UV sensitivity and overall weather resistance. Apart from this, the availability of this material makes it even more productive.

2. Objectives

- 2.1 To find the available areas in which the usage of acrylic can be made effective.
- 2.2 To study the previous similar work that has been made in this field.

3. Research methodology

The study conducted in this article is based on study observation on various materials from various published sources. The required data is collected from various links and websites such as ILA bulletin, news and articles published on various materials and their applications, journals on acrylic and thermoplastic composites and various scholar articles etc..

4. Acrylic

Poly (methyl methacrylate) PMMA also known as acrylic is a transparent thermoplastic. It is often used in sheet form due to its properties such as lightweight and shatter resistance as an alternative to glass. It often serves as an economical alternative to polycarbonate whenever extreme strength is not desired. It is often recognized by trade names such as Plexiglass, Lucite, Acrylite and Perspex. It does not contain any traces of bisphenol-A which is potentially harmful compound found in polycarbonate. Due to advancements in technology efforts have been made to increase the impact resistance and scratch resistance of this material.

5. Why Acrylic?

PMMA or acrylic is a strong and lightweight material. The density of acrylic ranged between 1.17-1.20 g/cm³ which is half less than that of glass. The impact strength of PMMA is greater than that of glass and polystyrene.

Acrylic can transmit upto 92% of visible light with just 3mm of thickness. With refractive index of 1.4905 at 589.3 nm it can reflect upto 4% light from its surface. Due to the environmental stability of acrylic

better as compared to polystyrene and polyethylene it is considered for most of the outdoor applications in the plastics industry.

6. Characteristics

Acrylic is a material with its properties such as transparency and durability because of which it is now being used in wide range of applications such as lenses of glasses, tail lights and various other instruments in a vehicle to reduce cost and productivity. The primary purpose which it serves is to provide good quality of transparency in various glass components such as shield glass in aquarium, window panes. Acrylic also has good compatibility with the human tissue with the help of which it can be used for the manufacture of various intraocular lenses. This procedure greatly helps to properly implant the lenses when the original lenses are removed in the treatment of cataract.

7. Different trade names of acrylic

Acrylite which is a trademark of company Evonik Cyro since 1976 [1]. Lucite is another trade name of acrylic which is a trademark of Dupont and was first registered in the year 1937 [2]. Perspex is also another trademark of Imperial chemical industries ltd [3] and Optix which is a trademark of Plaskolite company[4]. Oroglass which is trademark of Rohm & Haas.[5]. Cyrolite which is a trademark of CYRO [6]. Zylar which is a trademark of Nova Chemicals [7] etc..

8. Applications of Acrylic under various streams

As mentioned in the World Applied Sciences Journal on effect of Acrylate copolymers on the properties of Portland Cement Mortar Pastes [8] improved the characteristics Portland Cement Mortar. In this research paper it is stated that the polymer modifiers enhanced the physic- mechanical properties when compared to Portland Cement alone. Under the experiment that has been carried out it has been observed that as the concentration of the grafted polymers increases, the water cement ratio as well as setting time decreases and compressive strength was increased at nearly all hydration ages.

It has also been mentioned that the polymer modified mortars that have AA/BuMA [acrylic (AA)-co-butylmethacrylate (BuMA)] latexes that polymerized by solution technique with various monomer ratios tested for flow, setting time, strengths and combined water. From the test results, the effect of latexes on the physic-mechanical properties of Portland cement mortars are discussed.

In another research paper, various other properties of acrylic are discussed. The research paper has observed large strain mechanical behavior of Poly(methyl methacrylate) (PMMA) near the glass transition temperature[9]. It states that the mechanical behavior of amorphous thermoplastics, strongly depends on temperature and strain rate. In this study they investigated the large strain mechanical behavior of PMMA using uniaxial compression tests at varying temperature and strain rates.

Earlier a three dimensional constitutive model described the mechanical behavior of another amorphous polymer, poly(ethylene terephthalate)-glycol (PETG), is further applied to model the observed behavior of PMMA.

Further, the comparison with their experimental results revealed that the model is able to successfully capture the observed stress-strain behavior of PMMA, including the initial elastic modulus, flow stress, initial strain hardening, and final dramatic strain hardening behavior in uniaxial compression near the glass transition temperature as given in the fig. below.

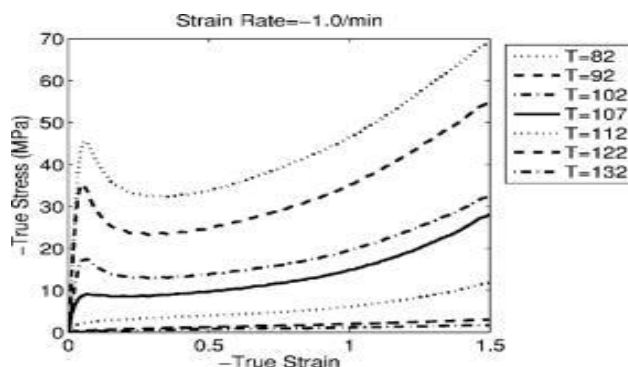


Figure representing properties of PMMA under variable temperatures.

In another research conducted on mechanical properties of PMMA/Hydroxyapatite nanocomposite[10] it has focused the study on the role of nano hydroxyapatite particles on the mechanical properties of

PMMA/Hydroxyapatite composites. In order to achieve a proper and homogeneous distribution of HA particles in the polymer matrix, mixer milling process was applied. Wear, compression and three-point bending tests were conducted. It was observed that the wear rate decreased by increasing HA content in both the atmosphere and artificial saliva.

Further the results of compression tests showed that the addition of 2.5 percent HA to PMMA promoted ultimate compressive strength, yield strength and modulus while caused to decrease elongation at break. Also it was elucidated that the addition of HA more than 2.5 wt% caused a decrease in both ultimate compressive strength and compressive yield strength and an increase in elongation at break.

9. Applications of PMMA

9.1 Architecture and construction

It is used in various streams such as door and window profiles for its outstanding impact, chemical and UV resistance as well as excellent performance in all weather conditions. PMMA facilitates light transmissions for the fast growth of plants. The simple and versatile machining options makes PMMA to create original and stunning surface designs for facades. Aquarium and marine centres makes use of PMMA for its strong and resistance to abrasive action. PMMA multi-skin and corrugated sheets are extremely tough. Even when PMMA is exposed to various elements they don't lose their stability and impact strength which makes them a most suitable material in Architecture and construction field.

9.2 Automotive and Transportation

As PMMA is a lightweight material and is easy to process and perform in all weather conditions thermoformed acrylic sheet is used for caravan window glazing. Different acrylic sheet products are used for motorcycles, aviation, helicopter and recreational vehicle windshields because of its properties such as double impact resistance compared to glass, uniform thickness tolerance and low internal stress levels for its consistent performance. In Aviation, PMMA is used for windscreens, windows and canopies because of its properties such as resistance to high inside cabin pressure, harsh UV radiation and double-digit subzero outside temperatures.

9.3 Automotive glazing

Car manufactures find it great interesting application of PMMA in glazing because of its advantages such as light weight, pleasant acoustic properties, and outstanding formability makes it a very suitable option for all the new design possibilities. Apart from this, it can be used for number plates, interior and exterior panels, trim, bumpers, fenders, and other moulded parts because of its excellent surface hardness, UV resistance and abrasion resistance properties.

9.4 Electronics and Energy

In LCD screens and monitors, PMMA makes a best choice for all top electronic brands for making screens because of its light transmittance and durability properties. Properties of PMMA makes it withstand the constant stress factor and thus ensures high energy conversion efficiency which make effective importance in solar energy by making it more economical.

9.5 Furniture and Design

Designers in various areas use acrylic material because of its exceptional properties such as transparency, toughness, and aesthetics. They find it economical to use for production of various products such as chairs, tables, etc.. Fabricators, use acrylic sheets for production of various products such as table mats, home wear, gift and table wear.

9.6 Lighting

Compared to traditional back lit systems, PMMA based lighting allows for unique combination of illumination and cool slim profiles. In construction of lamps, unsurpassed transparency of PMMA makes it an indispensable material for optical and technical applications. In LED applications, PMMA allows the light to come to life and maximize their light emitting potential. Innovative PMMA products have their effective application in skylights where it reduces the heat typically transmitted through windows, also cost and environmental impact is greatly reduced.

9.7 Medical and Health

In dental applications, PMMA is used for cavity fillings. Acrylic resins are used in the field of bone cement by most of the global leaders for high performance for the cutting edge technology to enhance further. Incubators, drug testing device, and laboratory equipment manufacturers benefit from acrylic properties such as

easy processing, purity of material, good dimensional stability, excellent bonding capability with other polymers, optical clarity, UV resistance, surface hardness, and good chemical resistance.

9.8 Visual communications

In Museum, PMMA sheet offers maximum optical clarity and resistance from UV rays which makes it suitable to use for protection of gallery exhibits such as photographs, models, and artworks. Acrylic products have the ability to color matched with other shades which makes it suitable for creating corporate identities as it can survive in any weather conditions. Signage is another application of acrylic products because of its illuminated display, weather resistance, attractive appearances, and easy construction.

II. CONCLUSION

Acrylic is a material that surely has varied applications in the future with the advancements in technology and research it surely can make a great contribution for the useful purpose in environment. Technology and research are effectively being re-engineered. Although the material is available with us for a very long time but its effective utilization in various engineering applications is seemed to be lacking and hence the purpose of this research paper is to make everyone aware of its characteristics and future scope. It can be a part of any developing country like India to achieve excellent performance. Some standards and improvement has to be done for developing more ways to increase the impact strength and durability of the material, which is suitable for Indian conditions so that the importance and utilization of this material can be made much faster. This is the time to seriously think of other useful alternatives to help meet the demands of the future generation.

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