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Polymethyl Methacrylate (PMMA)

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Report Abstract
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Nexant

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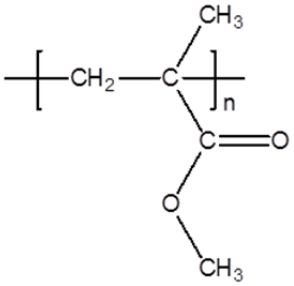
INTRODUCTION

Polymethyl methacrylate (PMMA) is the homopolymer of methyl methacrylate (MMA).



In reality, it is often formulated as a co-polymer where another monomer is employed in weight percent concentrations higher than 10 percent.

PMMA (also known as acrylic sheet) has some fascinating properties which have led to its widespread use in everyday life. It combines stability and chemical resistance with superior optical properties (transparency), moldability (castable and machinable), as well as being tough and shatterproof. PMMA is perhaps best known through its various trade names: Plexiglas™, Lucite™ and Perspex™. PMMA was originally developed and commercialized in the 1930s as a replacement for glass in glazing applications. It is made and consumed in many different forms, mainly sheet and base resin. Cast and extruded transparent acrylic (extrusion) sheet (PMMA sheet) accounts for about 60 percent of PMMA consumption. PMMA sheet is used for glazing, lighting, signage, displays, sanitary ware, and miscellaneous other applications.

The market demand for PMMA is currently almost 2 million tons per annum. Over 80 years after its initial introduction, the market for PMMA is continuing to rise significantly, boosted by its use for instance in the electronics and display sectors.

This PERP report discusses the key commercial technologies employed for making PMMA both in sheet and other forms (pellet, beads, powder and emulsions), as well as review developing technologies. The report contains detailed process descriptions and process flow diagrams for PMMA production by bulk, solution, suspension, and emulsion polymerization. Downstream process options are also described. Costs of production have been developed for the main routes to PMMA (i.e., continuous bulk, batch cell cast, continuous cast, and suspension polymerization). Commercial applications for PMMA are discussed and an analysis of the PMMA supply/demand market dynamics is given.

COMMERCIAL TECHNOLOGY

PMMA is produced through radical chain polymerization of methyl methacrylate (MMA). Most processes also employ comonomers.

PMMA is most commonly produced either in sheet form through a continuous bulk process. PMMA is also used extensively in injection and extrusion molding of plastics. PMMA for these applications is produced in the form of pellets, fine beads or powders, formed by extrusion of either bulk polymerized methyl methacrylate or directly from a solution of polymer-monomer "syrup" from which unreacted MMA is removed via heat treatment.

Technology developments for PMMA have centered on improvements in process efficiency and cost reduction. For instance, more efficient recovery of solvent and volatiles after the polymerization stage, as well as the use of low toxicity, recyclable solvents, and plasticizers, for use in the polymerization process.

This section of the report discusses the following technology options for PMMA:

- Continuous Bulk Polymerization to make PMMA in pellet form
- Cast Sheet
  - Batch Cell Casting to make PMMA sheet
  - Continuous Batch Syrup Polymerization (continuous casting) to make PMMA sheet
  - Pellet/Bead Extrusion to make PMMA sheet
- Suspension polymerization to make PMMA beads and powders
- Solution polymerization to make PMMA beads and powders
- Batch emulsion polymerization to make PMMA emulsions

An overview of downstream fabrication and processing is also given (i.e., thermoforming, injection molding, and extrusion).

PROCESS ECONOMICS

Cost of production estimates for the manufacture of PMMA using three bulk polymerization processes have been developed:

- Continuous bulk polymerization (on China, SEA, USGC, West Europe bases)
- Batch cell cast (USGC basis)
- Continuous batch syrup - continuous cast USGC basis)
- Suspension polymerization (USGC basis)

Sensitivity analyses are also presented for continuous bulk polymerization based on variations in MMA price, and plant capacity.

The first three techniques are 'bulk polymerizations'; while suspension polymerization is an alternative method to bulk.

The cost tables given in this report include a breakdown of the cost of production in terms of raw materials, utilities consumed (electrical energy, cooling water, fuel etc.), direct and allocated fixed costs, by unit consumption and per metric ton and annually, as well as contribution of

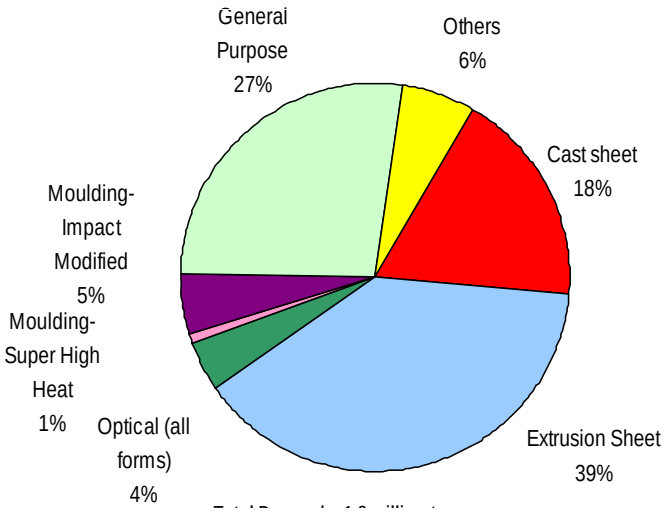
depreciation to arrive at a cost estimate. Capital costs are broken down according to inside battery limits (ISBL), outside battery limits (OSBL), other project costs, and working capital.

COMMERCIAL MARKET REVIEW

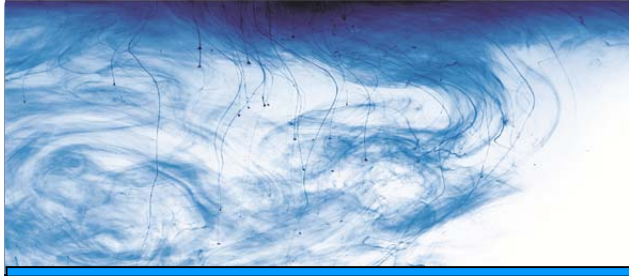
This report has a detailed section setting out commercial market applications and an additional section on understanding the PMMA industry discussing branding and value chain dynamics by PMMA product type and end-market sector.

Relatively new applications in the electronics and appliance sectors have emerged in recent years. In these sectors, PMMA sheet is used to make the light guided panel (LGP) for LCD screens, televisions screens and computer monitors. LGP is leading the demand growth among extruded sheet applications. PMMA is also used in combination with ABS to provide the shiny housing for flat screen televisions, a segment that has grown at double digit rates during recent years. The figure below gives a global overview of PMMA applications.

Global PMMA Segmentation by Fabrication Process
(By Major Application, 2011)



- Global PMMA supply, demand and trade data is given and discussed
- In addition, supply, demand and trade data is given and discussed according to key regions (i.e., Asia Pacific, North America, West Europe)



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