The largest application for cast acrylic sheets is in bathtubs and shower cubicles. Other applications include lightweight curved glazing, display shelves, outdoor signs, and display boards. Lucite's Perspex® and Arkema's Plexiglas® are common trade names for cast acrylic sheets.

In bath application manufacturing, a thin acrylic sheet is pressed into the required shape by thermoforming. The thin acrylic bath is then reinforced on the underside with unsaturated polyester and fiberglass. This process provides tubs and shower cubicles with a strong reinforced acrylic shell and a life expectancy of more than 30 years.

The importance of colour uniformity

A uniform colour on front and back surfaces is of primary importance in the production of cast acrylic sheet. Nonuniform colours can lead to poor colour matching when front and back surfaces are interchanged. Cast acrylic sheet manufacturers demand consistency between batches with minimal colour difference. Deviation in colour produces rejects and decreases overall efficiency, resulting in a less economical process.

Various grades of Eastman cellulose acetate butyrate have demonstrated a wide range of benefits for cast acrylic sheet producers, including:

- Elimination of flooding and floating of coloured pigments in polymerized acrylic sheets
- Reduction of titanium dioxide sedimentation during polymerization, providing uniform distribution throughout the cast sheet
- Improvement of metallic flake and pearlescent flake alignment
- Reduction of extender haziness or clouding, particularly for acrylic sheets containing barium sulphate

This publication provides documentation that flooding and floating of carbon black pigment in a grey cast acrylic sheet is significantly reduced with the addition of Eastman cellulose acetate butyrate (CAB-381-20).
Data

Visual colour differences
In Figure 1, flooding and floating have occurred in the system without Eastman CAB. This caused the black pigment to rise to the surface, resulting in the front surface being visually darker than the back. With Eastman CAB, a significantly more uniform grey colour is produced on the front and back surfaces. The flooding and floating benefits are theorized to be the result of the CAB reducing the agglomeration of pigments and extenders.

Figure 1. Cast acrylic sheet with and without Eastman CAB

Magnified colour differences
As shown in the magnified view of the acrylic sheet in Figure 2, the system without Eastman CAB produced a surface with noticeable black specks—evidence of pigment separation. The system containing Eastman CAB produced a surface with no black specks and a uniform grey colour.

Figure 2. Cast acrylic sheet with and without Eastman CAB (magnified)

Colour differences measured via spectrophotometer
The colour change (Delta E) between the front and the back surfaces was measured using a Minolta Spectrophotometer. The results show low Delta E values in the cast acrylic sheet with Eastman CAB, signifying even colour distribution. The system without CAB, however, produced sheet with high Delta E values, indicating a dramatic difference in colour between the front and back surfaces.

Figure 3. Delta E value comparison of acrylic sheet with and without Eastman CAB
Conclusion

This study confirms that Eastman CAB considerably reduces flooding and floating of carbon black pigment in grey cast acrylic sheet. This significantly reduces the colour difference between the front and back surfaces of the sheet. A more uniform sheet colour should result in reduced waste generated from product rejection. Using Eastman CAB-381-0.5 in cast acrylic sheet formulations allows manufacturers to deliver a higher quality cast acrylic product with enhanced efficiencies.

Appendix

Table 1. Cast acrylic formulation

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Description</th>
<th>Standard, wt%</th>
<th>With Eastman CAB, wt%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methyl methacrylate syrup</td>
<td>Polymerized less than 8%</td>
<td>98.85</td>
<td>97.35</td>
</tr>
<tr>
<td>Vazo® 64</td>
<td>Initiator/catalyst</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Tinuvin® P</td>
<td>UV absorber</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Aerosol® OT100</td>
<td>Demoulding agent</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Eastman CAB-381-20*</td>
<td>Pigment dispersion additive</td>
<td>—</td>
<td>1.5</td>
</tr>
<tr>
<td>White pigment paste</td>
<td>60% TiO₂ (Bayer Titan R-FK2) + 40% DIBP plasticizer</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Black pigment paste</td>
<td>20% Special Black 100 + 40% DIBP plasticizer</td>
<td>0.05</td>
<td>0.05</td>
</tr>
</tbody>
</table>

*Various *DuPont Ciba *BASF *Eastman *Bayer *Degussa *Note: Eastman CAB-381-0.5 is recommended when the methyl methacrylate syrup is polymerized to higher than 8%. In this example, the polymerization level was less than 8% and consequently CAB-381-20 was used.

Preparation of the cast acrylic sheet

• Methyl methacrylate monomer (MMA) was polymerized with an initiator. The MMA solution was polymerized to less than 8% in a sealed, heated tank (approximately 85°C) producing a low-viscosity syrup.
• The UV absorber, demoulding agent, pigment paste, and Eastman cellulose acetate butyrate (CAB-381-20) were then added to the syrup.
• The mixture was mixed in sealed tanks and defoamed at full vacuum.
• The defoamed coloured syrup was pumped between two large glass sheets which functioned as moulds for the acrylic sheet.
• A PVC seal was used around the edge of the glass sheets to control the thickness of the gap between the sheets. The PVC seal also prevented the syrup from escaping.
• The acrylic sheets were lowered into a tank of water @ 65°C for 200 minutes. The syrup was polymerized to approximately 90%. This reaction was exothermic, and a circulating water bath helped remove the exothermic heat.
• The sheets were removed from the water bath and the water drained off. The sheets were then placed in an oven at 125°C for 120 minutes to complete the cure to 100% polymerization.
• The glass sheets were removed, and the acrylic sheet was cut via automatic saw to the required dimensions.
• Protective sheet was applied to the acrylic sheet to guard against scratching.
• The sheets were then evaluated for colour differences.

Additional information

Flooding is the tendency of pigment particles to rise to the surface during drying/curing and produce a uniform surface colour which is different from that of the rest of the material.

Floating is the tendency of pigment particles to separate and concentrate in particular areas and also on the surface, resulting in uneven colour distribution.
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