Eastman cellulose esters
in refinish base coats
Application overview

Refinish coatings can be applied to the full range of vehicles, from passenger cars to commercial vehicles. Refinish coating systems are built in the same way as the original equipment manufacturer (OEM) coating systems. Passenger cars normally have a base/clear coat system, while commercial vehicles have a solid topcoat system. Since refinish coatings are applied manually, their appearance can depend on the skill of the spray operator. The difference between an experienced and less skillful operator can result in a >20% decrease in efficiency, which makes having a user-friendly refinish coating critical for maintaining appearance and color consistency. Another important consideration is volatile organic compound (VOC) restrictions, which typically require higher solids in paints, challenging formulators to find the right balance between cost and performance.

The typical layers involved in refinish coatings are shown in Figure 1.

Figure 1. Typical refinish coating layers

The base coat provides the main color to the refinish system, and it is critical that a uniform, high-quality finish is achieved to maximize the aesthetic impact. Designers want to accentuate the character of their finished products to create stylish and exclusive designs. To do this, metallic and pearlescent flakes are a very important part of the base coat, producing brilliant colors and iridescent effects that bring a vehicle’s curves, styling lines, and projections to life. The ability to control the orientation of these flakes, coupled with minimal defects, is critical in producing high-quality finishes that delight the eye and create a very desirable color-changing experience.

Eastman cellulose acetate butyrate (CAB) can help in the application and final appearance of base coats in a variety of ways. Eastman CABs help improve flake orientation, color consistency, color development, strike-in resistance, and early hardness development. They also ensure smoother films and faster solvent release.

Product-in-use details

Fast-drying CABs with high glass transition temperature (Tg) enable flake orientation and result in color harmony and uniform appearance. CABs provide the following benefits in refinish base coat applications:

- Optimized flake orientation control and face brightness
- Reduced dry-to-touch times
- Improved redissolve/strike-in resistance
- Reduced defects during application and increased first-pass yield
- Less color difference between wet and dry film with improved color matching
Selection considerations

Solids level
In low-solids base coats (less than 20% solids), Eastman cellulose esters—especially the CAB 381 series—are the first recommended products and come in many grades of varying molecular weight. Selection of a specific cellulose ester or blend depends on the desired formulation solids.

For higher solids targets (greater than 20% solids) or in case of formulation incompatibilities, Eastman Solus™ 2300 performance additive, Eastman CAB 531-1, or Eastman CAB 551-0.2 are recommended. Solus 2300 is an ideal solution for formulators trying to meet VOC and productivity targets without forfeiting appearance and performance.

Figure 2. Product selection guidelines based on solids level

VOC restrictions
If VOC restrictions do not apply, lower-solids and higher-viscosity systems can produce less expensive and more user-friendly formulations. As shown in Figure 3, such low-VOC formulations tend to have the best flop index values. If challenged with VOC restrictions and a high-solids system is required, cellulose esters that have a lower impact on volatile organic content should be chosen. Figure 3 details the effect of different grades of cellulose ester on the VOC of a typical base coat.

Figure 3. Effect of cellulose ester grade on overall VOC content and flop index of a typical refinish base coat
Benefits analysis of Eastman cellulose ester performance in refinish base coats

Optimized flake orientation control and face brightness
With CAB, the metallic flakes align flat and reflect more light, which enables an improved metallic film appearance. Figure 4 shows laser-scanning confocal microscopy images. The image of the coating without Eastman CAB shows many high peaks with almost double the average RMS Z value, indicating a rough surface. The image with Eastman CAB shows far fewer peaks; the metallic flakes are aligned, so they are flatter and more even with a much higher flop value and a surface that is very bright. The formulation without Eastman CAB produces a far lower flop value and is visually darker with a “grainier” appearance.

Figure 4. Microscopy images of base coats without and with Eastman CAB

Improved redissolve/strike-in resistance
Eastman CAB provides resistance to redissolve of base coats on application of the clear coat. Redissolve of the base coat by the clear coat can negatively impact appearance.

The images in Figure 5 of a base coat/clear coat interface were taken using a scanning electron microscope (SEM). The interface without CAB is diffuse due to solvent migration into the base coat layer. The image also shows poor alignment of aluminum flakes. The interface with CAB is clean, indicating lower redissolve of the base coat layer.

Figure 5. SEM images of the base coat/clear coat interface with 8% CAB
CAB allows wet on wet application with minimal color variation. Incorporating CAB in the base coat allows wet-on-wet application of the clear coat without redissolve/strike-in problems, which can minimize the color difference with improved color matching. This also speeds up turnaround time during production.

Figure 6 illustrates the redissolve resistance of a green metallic base coat with and without CAB. The shade of the green base coat was identical before the topcoat was applied. The base coat without CAB showed a lot of redissolve on application of the clear coat, drastically altering the appearance. The CAB-containing system produced excellent redissolve resistance, generating a coating with outstanding flake orientation, color consistency, and color development.

Figure 6. Panels of base coat/clear coat with and without CAB

Reduced dry-to-touch times
Due to its high $T_g$ and exponential viscosity rise, CAB provides rapid dry-to-touch times, facilitating reduced dirt pickup. CAB increases productivity and prevents surface defects with fast dry to touch. Reduction in dry time also decreases the occurrence of coating contamination, enables coatings to harden faster for early mar resistance, and speeds turnaround times.

Figure 7 demonstrates the increase in complex viscosity over time by coatings formulations containing CAB after application to the substrate. This behavior has the effect of allowing the coating to reach a dry-to-touch state in a much shorter period of time compared to the control with no CAB.

Figure 7. Complex viscosity of a control formulation and three formulations with varying percentages of CAB in acrylic-based formulation
Starting point formulation

Table 1 provides a generic refinish base coat starting point formulation containing CAB.

Table 1. Starting point formulation for generic refinish base coat

<table>
<thead>
<tr>
<th>Part</th>
<th>Raw material</th>
<th>Function</th>
<th>Wt%</th>
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<tbody>
<tr>
<td>A</td>
<td>Thermoplastic acrylic resin (50% in xylene/butyl acetate)</td>
<td>Main resin</td>
<td>30</td>
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<tr>
<td>B</td>
<td>Wax dispersion (5% NV)</td>
<td>Rheology additive for flake orientation</td>
<td>18</td>
</tr>
<tr>
<td>C</td>
<td>20% CAB 381-2 in butyl acetate</td>
<td>Flake orientation additive</td>
<td>35</td>
</tr>
<tr>
<td>D</td>
<td>n-Butyl acetate</td>
<td>Solvent</td>
<td>2.4</td>
</tr>
<tr>
<td>E</td>
<td>Additives</td>
<td>Additives for leveling or defoaming or wetting</td>
<td>0.2</td>
</tr>
<tr>
<td>F</td>
<td>Rheology additive</td>
<td>Rheology additive for anti-sagging</td>
<td>0.4</td>
</tr>
<tr>
<td>G</td>
<td>Aluminum paste (50% in xylene)</td>
<td>Metallic pigment</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>****</td>
<td>100</td>
</tr>
</tbody>
</table>

Procedure

1. Add parts A and B, and stir at high speed (1,500 rpm) for 5 minutes.
2. Add part C while stirring, and disperse for 5 minutes at 1,500 rpm. Make sure the CAB is mixed into the main binder.
3. Add part D to F while stirring, and disperse for 5 minutes at 1,500 rpm.
4. Add part G under slow stirring, and disperse at 5 minutes at 500–1000 rpm.
5. Dilute to application viscosity using xylene/butyl acetate/propyl acetate at a 5:4:1 ratio as a thinner (16–17 seconds).

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test data</th>
<th>Test method</th>
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<tr>
<td>Formulation</td>
<td>Solids content, %</td>
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<tr>
<td>Application</td>
<td>Application viscosity, sec (T-4 cup)</td>
<td>16.5</td>
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<tr>
<td>Performance</td>
<td>Flop index</td>
<td>19.81</td>
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<tr>
<td></td>
<td>Δ Flop index</td>
<td>3.82</td>
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Summary

Eastman CABs help improve flake orientation, color consistency, color development, strike-in resistance, early hardness development, smoothness of films, and solvent release speed in base coats. This enables formulators to save money by minimizing the pigment usage or selecting a lower-grade pigment with specialty pigments such as metallic flake and pearlescent. It also allows refinish base coat applicators to achieve excellent flake orientation with fewer defects and higher first-pass yield. The final result is a uniform, defect-free refinish base coating with an optimized visual effect that brings a vehicle’s curves, styling lines, and projections to life.

In addition to providing productivity and appearance improvements, refinish base coats also need to comply with VOC emission targets. Eastman offers a broad portfolio of CABs to help achieve the desired performance in both low-solids and high-solids base coats.

For help selecting the best cellulose ester for your specific need, contact your Eastman technical service representative or your authorized Eastman distributor.
As the world’s leading supplier of specialty cellulose esters for more than 85 years, Eastman has a long history of reliably supplying customers with consistently high-quality products manufactured using advanced processes and controls. Leveraging years of formulating experience and a diverse portfolio of more than 50 cellulose esters—CA, CAB, CAP, and C-A-P—for a variety of applications, our technical experts can provide guidance to help customers select the best cellulose ester or blend to achieve the specific performance desired for their unique application. Over the years, we’ve introduced innovative products that help meet customer needs and market demands, most recently Eastman Solus™ performance additives for high-solids coatings and Eastman membrane material products for membrane filtration. We work with regulatory agencies and industry associations on behalf of our customers to advocate for policies that allow industries to thrive, enabling sustainable innovation. At Eastman, our goal is to enhance the quality of life in a material way.
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