Edge Deletion of Sputtered LoE® Coatings

Background
Low Emissivity (Low-E) coatings were developed to fill the need for insulating glass (IG) products to have better thermal performance. These coatings have been successfully used in residential and commercial applications since 1983. Significant improvements in optical characteristics, thermal performance and coating durability have been made since the introduction of sputtered Low-E coatings. The silver metallic layer(s) in the Low-E coating stack provide the beneficial summer daytime and winter nighttime performance. Sputtered Low-E coatings remain the best coating type available due to their performance, aesthetics, price and customer acceptance.

When Low-E coatings were first developed for use in IG constructions, experience and testing indicated they would need to be edge deleted to eliminate corrosion at the glass edge. While significant improvements have been made to Low-E coatings in recent years the edge of the coating remains vulnerable to the environment if not edge deleted.

Low-E Coatings
Low-E coatings are produced by a vacuum deposition process called Reactive Magnetron Sputtering (RMS) and are comprised of multiple layers. The first RMS Low-E coatings were produced with one layer of silver, while advanced generations of RMS Low-E coatings have two, and even three silver layers (see Fig. CG01-1). The double and triple silver layer coatings have gained wide acceptance by window manufacturers because of the improved U-factor and lower Solar Heat Gain Coefficient as compared with the original single silver layer coating.

Regardless of the number of silver layers in the coatings, each Cardinal LoE coating has a durability layer are placed at the top of the coating stack. These layers protect the silver during shipping, handling, washing and fabrication of IG units.

However, these protective layers are on the face of the coating—not on the coating edge. When the glass is cut sizes into sizes, the silver at the glass edge is directly exposed to the environment. If coating corrosion due to moisture or adverse chemicals occurs, it will most likely begin at the edge where the silver in the coating stack is exposed.

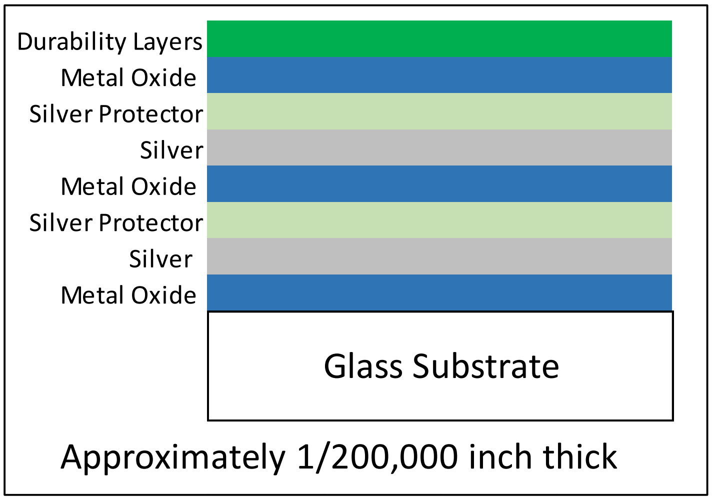

Fig. CG01-1: Typical double silver layer Low-E coating

Testing and Past Experience
Low-E coatings are similar to mirrors, they both use silver and have silver exposed at the edge. Experience with the weatherability of mirrors is analogous to the potential failure mechanism and weatherability of Low-E coatings.

Failures of mirrors normally occur at the edge and are caused by corrosion of the silver. In the mirror industry, this is called the “black edge effect”. When mirrors are exposed to relatively high humidity levels or to common cleaning solutions that contain acids, silver corrosion can occur. It is important to note that the degradation begins at the edge and propagates from this point. Black edge mirror failures have been reported to occur anytime from 3 months to 6 years, depending on the environment to which the mirror is exposed.

Tests conducted by Cardinal IG on edge deleted and non-edge deleted IG units indicate that silver corrosion similar to the black edge effect seen in mirrors, can occur on the non-edge deleted Low-E coating.

Competitive double silver Low-E coatings were tested without edge deletion. These samples were fabricated using a dual seal construction with PIB (polyisobutylene) as the primary seal and silicone as the secondary seal. The samples were exposed to accelerated weathering of 140° F, 100% relative humidity and UV light, a test known in the industry as the P-1 test. This test was chosen because Cardinal IG and some other IG and sealant manufacturers have used it to determine the durability and weatherability of IG unit constructions.

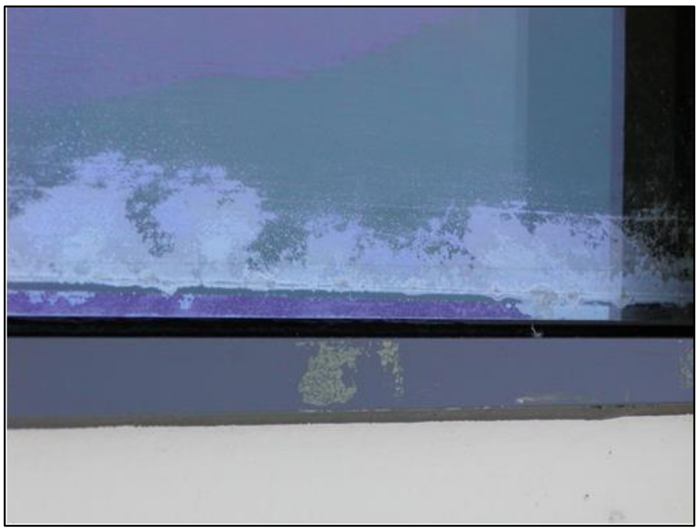

Fig. CG01-2: Coating corrosion due to no edge deletion

Significant corrosion of the silver in the Low-E coating was visible after 4 weeks of this test. The failure mechanism involved corrosion beginning at the edge and then progressing into the silicone secondary seal, through the primary PIB seal and into the viewing area of the IG unit. The corrosion and failure mechanism are important because PIB sealants are considered to be the best IG sealant materials for resisting moisture permeation. Since the PIB primary seal did not stop the corrosion of the low-E coating, corrosion of low-E coatings will most likely occur with any other sealant material when exposed to the same test conditions.

These tests showed that corrosion of the silver can create the following anomalies:

- Visual obstruction in the daylight opening of the IG unit.
- Premature seal failure of the IG unit (caused by a splitting of the coating layers resulting in moisture entering the airspace of the IG unit)

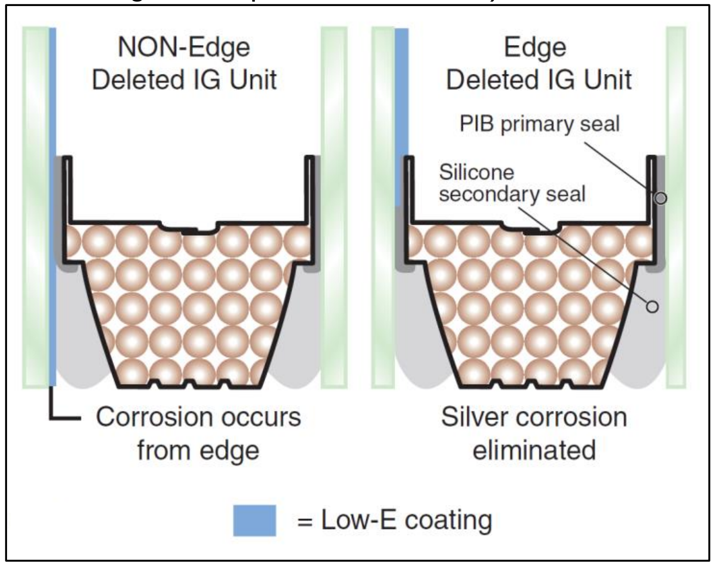

Fig. CG01-3: Edge deletion

As shown in Fig. CG01-3, corrosion occurs from the edge of the glass because the silver in the coating stack is completely exposed.

The same tests conducted for 1 year on Low-E coatings that had undergone edge deletion showed no degradation of the coating, with the seal of the IG unit intact. Obviously, the IG or window manufacturer cannot control the exposure of the glass edge to moisture or acidic conditions (e.g., acid rain or household cleaning solutions). Therefore, it is difficult to design a system that will not expose the edge seal of an IG unit to these conditions.

Procedures

It is recommended Cardinal's LoE coating be completely deleted around the periphery of the glass, as shown in Fig. CG01-3. Since the LoE coating contains multiple coating layers, all layers should be removed to ensure adequate and consistent adhesion of the sealants. The coating should be deleted using an edge grinding technique that removes all of the coating down to the glass surface. The deletion should reach to a height that does not contact the sealant(s) or, in a dual-seal system, to a minimum of half the primary sealant height.

Contrary to some beliefs, Cardinal's edge deletion process has not been found to cause damage to the glass, which would reduce glass strength. Independent testing on non-edge deleted and edge deleted glass samples has shown that there is not a concern for glass strength reduction with edge deletion.

Fabrication and Sealants

It is believed that the best unit construction with LoE coatings is a dual-seal unit with polyisobutylene primary sealant and a compatible secondary sealant. Other sealant systems have been successfully used with LoE products. For current recommendations on sealant compatibility your Cardinal CG sales representative and the sealant manufacture should be contacted.

The Argument for Edge Deletion

Low-E coatings have been used in IG units in North America since 1983 to improve the thermal performance of the insulating glass unit. Silver is used as the main coating material, and experience with mirrors (as well as accelerated testing of low-E products) indicates that the coating is most vulnerable at the edge of the glass. Therefore, the coating should be edge deleted around the glass periphery.

If the low-E coating is not edge deleted, corrosion and delamination of the coating can take place and the IG unit seal integrity compromised. In the long run, the cost of replacing an IG unit far outweighs the cost of edge deletion.

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