

Organic/Inorganic Coatings Cured by Ultraviolet Light and Moisture for Automotive Glass

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ABSTRACT

Ceramic enamel (frit) is an opaque, decorative border found along the periphery of glass windshields used in passenger and commercial transportation vehicles, as well as, architectural spandrel and decorative glass applications. In transportation and architectural applications, the primary function of ceramic enamel is to conceal aesthetically unpleasing, but essential structural components and to prevent photodegradation of the underlying polyurethane adhesive, which is used to bond glass windows into supporting structures.

Typically, ceramic enamels are applied by screen printing ceramic slurry onto the glass substrate, which is subsequently fired in a furnace during the glass-forming process. The fired enamel is then primed with solvent-based primer(s) to facilitate adhesion between the enamel and polyurethane adhesive.

Currently used ceramic enamels, and the associated processing and application of these materials for automotive glass bonding, have the following drawbacks: (i) high firing temperatures resulting in high energy costs, (ii) introduction of glass warpage and dimensional defects, (iii) volatile organic compound (VOC) emissions, and (iv) extra processing steps due to application of primer(s).

As a result, a novel, organic frit has been developed to replace ceramic enamels that are commonly used in transportation glass applications. This organic coating crosslinks via exposure to ultraviolet (UV) light, and subsequently undergoes a secondary moisture-curing mechanism, via exposure to ambient moisture, to fully cure the coating as shown in Figure 1.

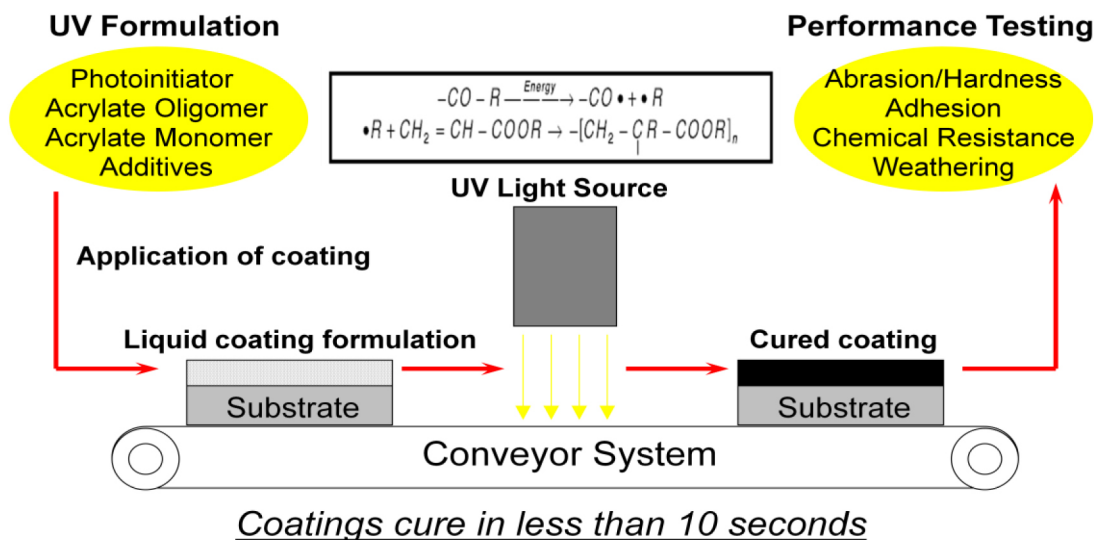


Figure 1. Curing process for Organic Frit

The resulting coating exhibits durable adhesion to both automotive float glass and polyurethane adhesives without the use of any primers. Moreover, the resulting performance of these novel coatings has been validated in both outdoor and accelerated weathering testing.

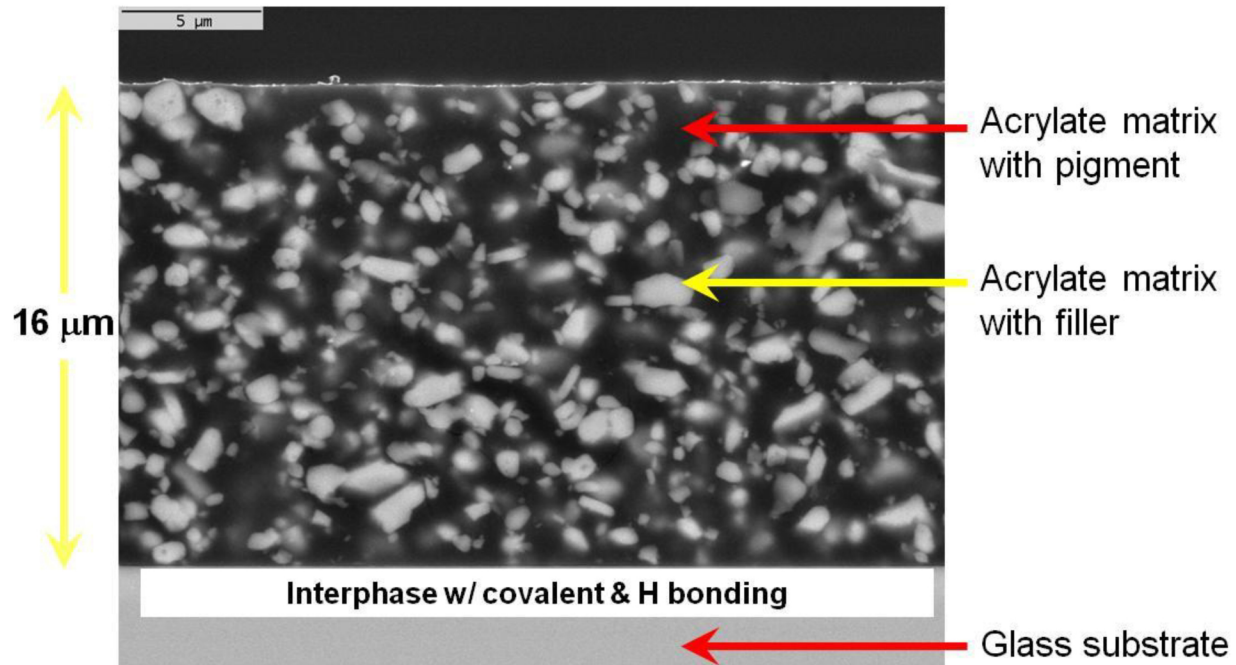


Figure 2. Coating structure under Scanning Electron Microscope (SEM)

KEY WORDS: 1=Frit, 2=organic, 3=Ultraviolet Light, 4= Ceramic Enamel

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INTRODUCTION

The Need to Reduce Energy Consumption, VOC Emissions and Scrap Waste

Due to increasing energy costs and continuous scrutiny on curbing greenhouse gas emissions (Tables 1 and 2); glass

fabricators need to maximize furnace efficiency for throughput of tempered and laminated windows.

Table 1. Industrial Energy Cost Projection, nominal dollars per million BTU.

SOURCE	2007	2010	2015	2020	2025	2030	Growth (%)
Liquefied Petroleum Gases	23.38	23.00	32.62	37.17	40.49	44.93	2.90%
Distillate Fuel Oil	16.82	16.86	25.57	29.14	32.67	36.52	3.40%
Residual Fuel Oil	10.49	16.20	23.64	27.05	29.57	32.95	5.10%
Natural Gas	7.52	7.27	8.11	9.66	11.03	13.16	2.50%
Metallurgical Coal	3.61	4.60	5.09	5.69	6.28	6.40	2.50%
Other Industrial Coal	2.43	2.67	2.98	3.27	3.55	3.88	2.00%
Coal to Liquids	--	--	1.40	1.59	1.81	1.98	--
Electricity	18.63	19.72	21.20	24.63	27.71	31.30	2.30%

Source: National Energy Information Center^[1]