UV Curable Putty for Automotive Repair

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Introduction

Automotive repair and refinish is a laborious process containing a number of steps, including repairing the defect, preparing the surface for painting and applying the numerous layers of paint that comprise an automotive finish. Improving any one of these steps can result in savings for the body shop by enhancing the shop's productivity and throughput.

Possible areas for improvement are: lowering the VOCs of the materials used, increasing the current product workable pot-life, widening the sandability window from what is currently possible, increasing cure speeds, improving adhesion to various substrates/basecoats, and lowering the processing cost per vehicle.

Ultraviolet or UV curable products have been accepted in many markets because of their speed of cure, environmental compatibility (low VOC) and reduction in overall consumption of other resources, such as energy and reduction of waste[1]. Based on these types of product characteristics, one could expect that the use UV curable materials would also benefit the automotive aftermarket industry.

UV curable products offer the same performance properties as most conventional products, but with the added advantage of lower VOCs, longer application pot-life, and increased curing or processing speed. UV-A curable putties can deliver all of the required properties of conventional two component system (2K) putty. UV-A curable putty is capable of accepting high filler levels, improving the sandability window, and displaying adhesion to a multitude of substrates.

Current Process Focus

The job of the body shop is to prepare a car for the paint process. Small dents and scratches are sanded and filled to smooth out the surface irregularities. If this stage is not done properly, it will be difficult, if not impossible, to achieve a good paint finish. Body putties are used to fill in large imperfections and restore the body contour to its original shape.

The first step performed by the body worker is to physically prepare the substrate to accept the putty, usually by a combination of sanding and metal repair. The substrates to which the putty must adhere range from galvanized metal, steel and aluminum to e-coated primed metal. After sanding, the surface of the metal is then wiped down to remove any dust or oils which might impair the adhesive properties of the putty, prior to the application of the putty.

Current conventional technology is based on 2K systems in which strict mixing ratios must to be followed, based on the individual manufacturers' specified recommendations. Along with the proper mix ratios, there are processing restrictions of 2K systems which dictate that sufficient time be allowed for curing ("hardening") to occur before the coating can be sanded and transferred to the paint shop for priming or basecoating.

Although a 2K spot repair displays surface cure, it may take up to 12 hours to complete through-cure before it can be used for the next phase in the repair or paint process, dependent on type and amount of hardener and ambient temperature. Inadequate cure time may result in:

- Having to re-apply putty because of shrinkage
- Subsequent poor surface preparation for the paint shop
- Improper curing
- Lack of adhesion
- Poor sandability

Too much cure time may result in:

- Too hard of a surface to sand and smooth
- Improper hardness for intercoat adhesion, if multiple applications are required

Repair with UV-A Putties

The initial repair steps are the same for both UV and thermally cured (2K) systems. Good sanding technique and removal of all oily residues are essential. The difference enters into the process with the ease of use of a UV-A curable putty. UV curable systems consist of one component, and are ready to use. The body shop no longer needs to be concerned with proper mix ratios of material or catalyst levels.

Conventional body putties are typically thermoset plastics. In 2K systems, the hardener acts as a catalyst producing a chemical reaction, generating internal heat and activating the cure mechanism. For the system to work effectively, the minimum ambient temperature needs to be 64° F, with the best performance properties between 72° and 80°F.[2]

Unlike conventionally cured putties, temperature is not a major factor with UV-A curable systems. UV-A systems are "cool curing", as they require a low energy light as a source of activation for the cure process and not heat. Contrary to conventional technology, the window of process ability is not a crucial factor for UV-A putties. The putty remains pliable until exposed to a UV-A energy source. Once cured, it can be easily sanded days or even months after curing without negative impact to subsequent coating layers.

Typically, lightweight polyester body putty can cure to a tack-free state in 15 to 20 minutes, while the effective application pot-life of a 2K system can be as low as 5 to 8 minutes[3]. The shorter application window often restricts repairs to working smaller limited areas. Using more than the recommended amount of hardener will further reduce the cure time of a 2K system, but it can negatively affect the final properties of the cured putty. It is this type of problem which can hurt the coating performance further on down the refinish process.

The use and application of UV-A curable putty is neither time- nor temperature-restricted. Without exposure to a light source to activate the system, a UV-A putty has a virtually endless pot-life, and the processing time has very few restrictions. This longer workable processing time allows for:

- Proper adhesion to many materials—direct or intercoat
- Ample time to smooth and sculpt out air pockets with the spreader applicator, creating an exact contour of the panel
- Reduction of imperfections which might require additional post cure work
- Elimination of the need for a sealer coat over the coarse putty application

Surface cure of UV-A curable systems can be achieved within one minute after exposure to a UV-A light source. Complete through-cure can be achieved after five minutes exposure to a total depth of ⅛" to ¼". Multiple layers can be deposited in relatively rapid sequence for the total film build required, with excellent intercoat adhesion, with or without additional surface preparation.

Filler Selection

The main purposes of the inert filler ingredients are to reduce cost and add strength and structure to the putty. The filled formulated product should:

- Resist shrinkage after application
- Adhere to various substrates
- Maintain sufficient flexibility
- Be easily sandable after cure

As stated, the appropriate selection and level of inert fillers reduce overall cost, and improve processing along with offering unique properties to the product. The same inert fillers that work well in 2K systems are easily incorporated into UV–A systems. The types of fillers may include (but not be restricted to) barytes, calcium carbonate, clays, feldspar, mica and talc. Some of the typical fillers, such as some grades of feldspar, are to some degree UV transparent, and are excellent for selection and use in UV curable systems for that reason.

Film Build

In UV curable systems, the curing mechanism involves the generation of free radicals via activation by the light energy. If the photoinitiator is not activated properly, incomplete cure is certain. Some thicker film builds can lead to incomplete through-cure, which might result in long-term delamination or rusting. The use of multiple thin film builds are strongly recommended, along with appropriate choice and concentration of photoinitiator.

The film build (application thickness) of the putty layers should not be more than ⅛" to ¼" of an inch per layer (as opposed to ¼" to ⅜" typically for 2K putties[3]). It has been observed that too thick of an application film build in conventional 2K systems can create high internal temperature, thus leading to poor performance of the putty.

It is fast and easy to apply multiple layers of UV-A curable fillers to build the final refinished profile. To achieve greater film build and assure complete curing of individual layers, each layer is exposed for a short time to initiate cure (one to two minutes UVA light source). Subsequent layers can be added using this same procedure with excellent intercoat adhesion. The topmost layer is then exposed for the full five minutes. It is recommended that no more than three layers should be applied to assure complete through-cure of the lower layers. It has been observed that due to the smoothness of the putty, it is possible to eliminate the application of a putty glaze coat, thus reducing the additional labor, cost of material, and time.

Curing Time and Light Sources

Conventional 2K systems rely heavily on thermal energy and time to complete the crosslinking of the product. Body shops typically have high energy costs due to drying and baking ovens. The energy costs for UV-A lamp operation are generally lower than the costs required to bake a coating.

UV-A lamps are ideally suited for automotive small body repair and refinish. This class of light is easy to operate and the lamps can be hand-held or mechanically mounted on a fixed frame. It is important to know that the light focal distance from the refinish repair surface and the area of exposure will determine speed, depth, and area of cure. Following the lamp manufacturers[4] recommendation (Table 1) is always prudent.

Table 1. Commercial UV-A Lamps

Company/Brand	Light Model	Cure Area (in^2)	Power Source
H&S AutoShot	UVA 400A	10 x 10	110V 16A
Panacol	UVF 450	14 x 14	110V 10A
Pro Motorcar	UV 250	4 x 5	110V 10A

In lieu of forcing the process time used for 2K unsaturated polyester putty, (an average of 30 minutes at 70°C bake time plus additional set time), UV-A system processing is on the average of five minutes at room temperature. This is a significant reduction in process time and energy costs which equals increased profitability.

Advantages of UV-A Putty

The goal for UV-A curable automotive refinish, spot cure, putty is to offer an environmentally friendly alternative to 2K systems. UV-A putties can be highly filled (>50% inert material loading) and display properties similar to or better than a 2K system in three to five minutes, applying typical film builds. A significant advantage over conventional types of refinish putty, which contain styrene or other carrier solvents, UV-A curable putties do not have to wait for solvent to flash off. Improper solvent flashing can be the source of entrapped gasses and film imperfections which may create defects, unseen at the time of repair.

Low intensity UV-A curable products can be formulated to offer specialized performance characteristics, yielding cured films in a fraction of the time it takes a conventional 2K putty to dry enough to be sanded for further processing.

UV-A putty product profile:

- Eco-friendly
- Easily accepts high levels of inert fillers
- Typically displays a 3-5 minute cure
- No solvent flash required

UV-A product features:

- 1K product with 2K performance
- Reduced VOC/styrene free vs. 2K systems
- Ready to use, no liquid hardeners
- Reduced time between application of multiple film layers
- 1 minute surface cure
- 5 minute cure to sandability
- Adhesion to prepared substrates
- Low thermal energy consumption
- Excellent sandability—wet or dry
- Reduced labor cost and increased body shop efficiencies

Conclusions

UV-A curable putties offer significant advantages, such as ease of application, faster processing and increased throughput. UV-A curable putties for use in automotive spot cure refinish meet the targeted goals of efficiency and performance. The use of low intensity UV-A lights, with proper binders, stabilizers and photoinitiator packages, opens the opportunity for the introduction of new products for automotive refinish. UV-A curable putty can make the job simpler, reduce time and increase productivity.

References

[1] Goldschmidt – Streitberger, *Basics of Coating Technology*, pg. 653
[2, 3, 4] Overson, Reed, "Using Body Filler", http://www.roadsters.com/filler/