



**Alan K. Nudelman**  
*President*  
 Composition Materials Co., Inc.

# New Options for Masking of Medical Devices— UV Curable Masks

## Masking for surface finishing

Masking presents unique challenges within the medical device industry. Components are expensive, of high precision and subject to strict standards of manufacturing to avoid contamination. In today's environment, quality and cost go hand-in-hand. Masking can add significant cost, decrease throughput and cause defects requiring rework or scrapping.

## Costs of masking

Masking of components and surfaces is a necessary part of every finishing process. Whether for grinding, abrasive cleaning such as grit blast or vibratory finishing, acid stripping, shot peening, anodizing, chemical milling, plasma spray or plating, masks act as a self-sacrificing barrier for surface protection. The more complex and intricate a component, the longer it takes to apply and remove traditional masks such as tapes, waxes and solvent based lacquers.

The costs associated with masking may not be readily apparent, as the masking material itself is typically not the major contributing element to overall cost. The major cost derives from the masking process itself. Additional costs include: labor to apply and remove the masking; scrap components; component reworking; production bottlenecks; elapsed time; floor space; waste disposal and OSHA and EPA compliance for solvent-based masks.

When all cost elements are considered, the process with a lower labor component and lower defects is the winner. If one only considers the lowest cost masking material, the lowest total cost is rarely achieved.

## Masking methods

The most popular products used in most masking applications include tapes, lacquers, waxes and reusable boots and plugs.

### *Tapes*

Masking tapes range in composition from the simple, low-cost

paper tapes typically associated with painting, to expensive, heat-resistant polyester, polyamide and silicone used in high temperature surface finishing. Tapes are dispensed from a roll and are cut to fit the area to be masked. Some can be purchased in die-cut shapes, but this can be costly and is usually limited to high volume production of a single component configuration.

Masking with tape is perhaps the most labor-intensive masking process, especially for complex surfaces. However, if the geometry is simple and the tape holds up to the process, taping can be effective and low cost. Tapes are applied by hand, and in most instances of multiple surface processing operations, are re-applied in the same areas due to abrasion and wear. It is not uncommon for an operator to spend two to four hours masking a single intricate component.

In addition to being time consuming for difficult geometries, the taping process can also pose dangers for employees. Despite the best protection, employees can sustain finger cuts from razor blades and from the tape itself. These injuries can result in lost time as well as other associated resultant costs.

## Boots, caps and permanent masks

Boots and molded caps, typically made of rubber or vinyl, are used in high volume processing of components with no dimensional variations. Because the cost of molds can be quite high, it is cost prohibitive to have boots and caps molded for small volumes, or for components with varying configurations or dimensions. Thus, molded boots and caps are not suitable as a universal masking media. Rather, they are product-specific. For long runs, where they fit well, boots and caps are a cost effective method.

Boots and caps rely on press-fit tolerances and elasticity to affix themselves to the components. However, this is not adequate protection for liquid processes such as acid cleaning and plating. Boots and caps will eventually wear out after repeated use. They

*continued on page 48*

*New Options for Masking of Medical Devices, continued from page 47*

can also loosen and fall off during the process, creating costly rework or scrap.

Permanent masks may also serve as fixtures to hold the part during the finishing operation. Because of their high engineering and design costs, they are only suited for long runs. Also, for applications such as plating, where a very tight fit is required, they may not afford the required quality.

### Lacquers

Typical masking lacquers are solvent-based and require a prescribed curing time to allow the solvent to evaporate and for the remaining resin to cure, or harden, on the components. This type of curing process requires that masked components be stacked or racked and left undisturbed for a period of time ranging from several minutes to several hours. Not only is the process bottle-necked, but valuable production space is consumed with curing parts.

Lacquers are used because the material cost is low and because they may stand up to plating and chemical milling chemicals. However, the total cost of using these masks is high for the following reasons.

The solvents contained in many lacquers are the same solvents that are being restricted or banned in the workplace by governmental agencies for health and safety concerns. In addition, solvents can be extremely flammable, posing other health and safety risks. Solvents—and products containing solvents—must be carefully monitored in the work environment.

Lacquers are predominantly watery, low-viscosity products. In order to provide adequate protection as a mask, it may be necessary to repeat the dispense and cure cycle several times to build the proper mask thickness. Multiple masking cycles create delay and add cost.

Finally, lacquer removal can be difficult. Typically, lacquer-masked components are first warmed, then soaked in a solvent such as acetone. Solvent-based masks are generally a last resort for use in situations where they represent the only workable masking solution.

### Waxes

Wax is perhaps the least expensive material that can be used for masking. However, it is difficult to work with, as it must be heated above its melting point to apply (150° F or higher). Heating requires special handling equipment and thermal energy, which can thus generate a surprisingly high utility cost. Typically, wax is poured into components to protect the internal cavities.

Parts with tight dimensions and serpentine pattern cavities must be pre-heated to allow proper flow of wax. Dipping is the only practical method of coating external surfaces, because hot wax cannot otherwise be applied in a controlled fashion.

Removal of wax requires the same melting process as the application of wax, with the exception that the component must now be heated with the wax. Wax removal is usually conducted in a hot water bath. Care must be taken to ensure that all wax is removed from the components, and the water bath must be well filtered or replaced frequently to keep the water clean. An additional cleaning operation is often required after wax removal.

### A new option: UV curable masking technology

Most companies contact us because they are experiencing quality, rework or scrap problems with their current masking approach, or because of concern about high labor hours. A new technology to address all of their concerns is now available with the use of ultraviolet (UV) Curable Masking Resins.

Worker-friendly and OSHA-compliant, UV Curable Masks are solvent-free, low odor, non-flammable liquid resins that cure in seconds upon exposure to ultraviolet light energy. They are specifically formulated to have no effect upon the metallurgical characteristics of the surface being masked. These resins are urethane-based and contain no heavy metals, silica or other compounds that can alter the properties of the component surface or the finish being applied. Once cured, these resins can be handled like any industrial plastic. When removed by recommended methods, UV Curable Masking Resins leave no residue.

These resins are single-component formulations that eliminate the need to measure and mix prior to using. UV Curable Masks are available in a variety of containers to accommodate any dispensing system, ranging from small syringes to bulk packaging measured by volume or weight.

While some formulations may be simple and others more complex, UV masking resins are typically comprised of five basic elements, as illustrated in Figure 1:

- Photoinitiators
- Additives
- Monomers
- Modifiers
- Oligomers

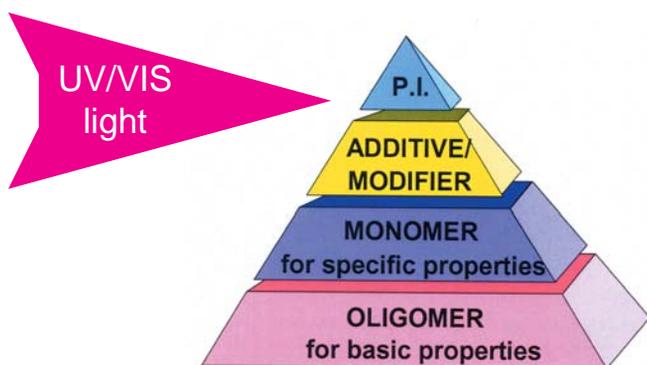


Figure 1. Typical Light Curing Urethane Acrylate Adhesive

**Photoinitiator (P.I.)** – Component of the UV Masking Resin that begins the polymerization (curing) process when exposed to UV light energy of a compatible wavelength. In dual curing resins, a secondary initiator may also be included that utilizes heat to begin polymerization in areas where UV light cannot reach, and thus fully cure the masking resin, such as in core cavities.

**Additives** – Filler chemicals that are used to add or enhance specific resin properties such as flow rate, wetting, tack-free surfaces, color or fluorescence.

**Modifiers** – Component of the UV Masking Resin that can increase durability by improving impact and crack resistance of the resin.

**Monomers** – Single units of polymers that provide adhesion to surface materials such as titanium, aluminum, iron and nickel or cobalt-based superalloys.

**Oligomers** – Oligomers are the backbone of the resin and are comprised of medium length polymer units, which provide the basic properties of the UV Masking Resin such as hardness, elongation and chemical resistance.

#### How do UV curable masks work?

The UV light curing process begins when the photoinitiator in the mask is exposed to a UV light energy source of the proper spectral output. Its molecules split into free radicals (initiation), which then begin to form polymer chains with the monomers, oligomers and other ingredients (propagation), until all of the ingredients have formed a solid polymer (termination). (See Figure 2.) What was once a liquid is now a solid resin.

#### UV curing systems

Critical to the UV mask curing process is an ultraviolet light energy source. Several types of UV curing lamps and systems are commercially available. Spectral output of the lamp, intensity, component configuration, desired production throughput and

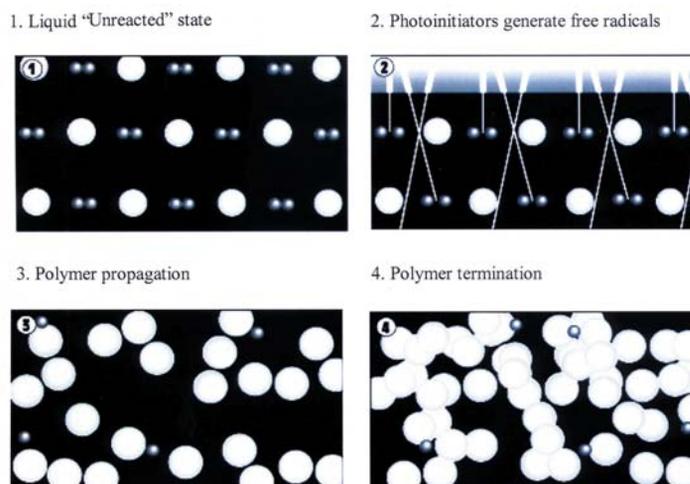


Figure 2. UV Light Cure Process

budget are all factors that help determine which type of UV curing system is appropriate.

UV lamps may be grouped into two broad categories. UV spot lamps generate high intensity UV energy that is directed through a fiber or liquid filled light guide, typically 5-8 mm in diameter. Flood lamps can be used which create light footprints up to 8” square.

Systems are also available that combine curing lamps with dispensers or conveyors for semi-automated production. This permits continuous in-line processing of components with no delays.

#### What types of UV curable masking resins are available?

There are three basic grades of UV masking resins. They can be grouped by their removal mechanism as peelable, water-soluble or burn-off.

##### Peelable Masking Resins

Perhaps the most versatile of UV Masking Resins, the peelable grades provide good adhesion to most clean metal surfaces, are resilient enough to withstand a variety of surface treatment processes and can be removed through a simple peeling process. Cured in a few seconds with UV light, peelable masks have been successfully qualified for surface protection in processes such as grit blasting, shot peening, acid cleaning, plating and anodized coatings. The surface bond is very strong and durable, possessing sufficient adhesion to survive through multiple surface cleaning and processing operations, eliminating the need to strip and re-mask between processes. Peelable UV Masking Resins offer uniform adhesion from edge to edge, preventing processing media from creeping underneath.

*continued on page 50*

*New Options for Masking of Medical Devices, continued from page 47*

Peelable UV Masks are removed by prying up an edge manually or with the help of a non-abrasive tool, then pulling. The elasticity of the material typically permits fast removal of the mask in one piece rather than in fractured segments. No residues remain on the surface after the mask is removed. The peeling process is made even easier by warming the cured masking resin to 120-150° F in a warm water bath or oven, or by using a localized heating element.

The peeled material, essentially a plastic resin, is non-hazardous and may be disposed of in accordance with local regulations for industrial scrap plastic.

#### *Water Soluble Masking Resins*

Water soluble UV Curable Masks provide excellent protection for “dry” finishing processes such as grit blasting, grinding, shot peening and plasma spraying. They can be applied using the same methods as the peelable grades. However, the truly significant feature of the water soluble grades is their removal mechanism. Unlike the burn-off and peelable grades, which are urethane-based, the water soluble masks are formulated with water soluble polymers.

As their name suggests, the water soluble grades dissolve in liquid. The ideal removal method utilizes heated water (140° – 180° F) and a spray wash or agitated/ultrasonic bath. The mask completely dissolves in the water and leaves no residue on the component surface.

#### *Burn-off Masking Resins*

These grades typically offer the best surface adhesion and provide the greatest resistance to heat and aggressive chemical solutions such as acid/alkali baths. Heat curable grades can be used for core cavity sealing to protect from debris, plating baths, and laser burn-through during drilling operations. Surface curing with UV light may take 20-30 seconds under a flood lamp.

The removal process for a burn-off grade mask requires that components be baked in an air-enriched furnace at temperatures between 900° F and 1400° F. Complete burn-off can be achieved in as little as 15 minutes for thinly coated surfaces. For core cavities, cooling holes or thick mask coatings, a bake cycle of one hour or slightly longer may be required. Obviously, burn-off masks are limited to parts that can tolerate high heat.

In many instances, an existing heat treating operation may also be used to burn-off the mask. The burn-off process effectively incinerates the mask and leaves no residue on the component surface. The composition of the UV Curable Mask allows it to

completely combust and be exhausted from the furnace. And, the metallurgy of the heat-treated component remains unaffected by the UV Curable Masking Resin.

#### **Medical device applications**

The examples below highlight the utility of UV curable masks as applied to knee tibial components.

1.) Generally speaking, the posterior aspect of the implant (the side that eventually mates with bone) is roughly textured. Some manufacturers “grit blast” this surface with aluminum oxide—an extremely aggressive blast media. During the blasting process, the anterior aspect of the implant (which will be highly polished) must be protected. In this instance, SpeedMask—the UV curable polymer masking material—is used in its peelable form. (See Figure 3.) It is then cured under a UV lamp for less than one minute. The blasting is performed, and then the mask is warmed in a sonic bath or with a heat gun and the mask peels off easily by hand. There is no residue, and the curing can be conveyORIZED.



*Figure 3. SpeedMask in its peelable form.*

2.) The second example involves polishing the anterior aspect of the component. Now, the posterior aspect of the implant must be protected to avoid contamination by buffing compound. Although texturing is designed to enhance bony in-growth, the porosity of this makes most masks difficult to remove. Thus, in this instance, a water-soluble SpeedMask is recommended. As in the first example above, SpeedMask is applied, the component is placed under UV light and the piece is then buffed. Finally, a sonic bath removes the water-soluble mask. Again, there is no residue. This process even works well for sintered ball surfaces, which are extremely porous.

**Summary**

SpeedMask's versatility is equally as demonstrable in the finishing of hip components and surgical instruments. One customer employs the process to re-work up to 20 "reject" knee components per day-components which otherwise are potential "scrap."

UV Curable Masking Resins provide significant improvements in performance compared to other masking solutions available. Cost reduction and enhanced productivity are primary drivers in the pursuit of new applications for use. Advantages of UV Curable Masking include:

- 1) The process lends itself to automation.
- 2) Short runs also lend themselves to significant savings.
- 3) Labor can be reduced significantly.
- 4) Scrap and rework can be reduced or eliminated.
- 5) The process is environmentally friendly.

*Editor: Composition Materials Company (CMC) produces Plastic Blasting Media (Plasti-Grit) and other abrasives and distributes abrasives, masking systems, fillers and extenders for industrial and consumer product applications. Alan K. Nudelman received a B.S. in Industrial and Mechanical Engineering from the University of Illinois and attended the Graduate School of Business Administration at the University of Connecticut. After beginning his career with IBM and serving in various marketing and business management positions, Mr. Nudelman assumed responsibility as President of CMC in 1988.*

Composition Materials Co., Inc.  
125 Old Gate Lane  
Milford, CT 06460 USA  
203-874-6500 (phone)  
800-262-7763 (toll-free)  
Web site: [www.compomat.com](http://www.compomat.com)  
E-mail: [info@compomat.com](mailto:info@compomat.com)

**PCC Structurals - SSBO**

4600 S.E. Harney Drive  
Portland, Oregon 97206-0898

**PCC Schlosser**

345 N.E. Hemlock  
Redmond, Oregon 97756

**Advanced Forming  
Technology**

7040 Weld County Road, #20  
Longmont, Colorado 80504-9423

**Wyman-Gordon Carson City**

2727 Lockheed Way  
Carson City, Nevada 89706-0791

**Wyman Gordon Cleveland**

3097 East 61<sup>st</sup> Street  
Cleveland, Ohio 44127

**Supplying State Of The Art Castings And Forgings  
For The Medical Orthopedic Industry Since 1962**



**Randy Little - Director, Medical Products**

Ph: 503-794-2053 • Fax: 503-794-2047 • [rlittle@pccstructurals.com](mailto:rlittle@pccstructurals.com)