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Wire Arc Spray Coating

A Technical Guide to Masking

Technical Application Series

Wire Arc Spray Coating
A Technical Guide to Masking

Save Time and Money with the Right Materials and Methods

Tape

GBI manufactures pressure sensitive thermal spray masking tapes. These materials must be smoothed and pressed with force/pressure to create a good bond of the masking tape to the component surface. Silicone adhesives are always used for thermal spray masking applications for two reasons: 1. Silicone adhesives typically resist the continuous high temperatures approaching 500°F/260°C that can be associated with twin wire arc spray coating. 2. Silicone adhesive releases cleanly from most surfaces leaving no residual adhesive.

Application of wire arc spray at a 90° angle to the target surface.

Generally speaking, thermal spray masking tapes can be constructed from silicone rubber, woven fibreglass, metal foils, and silicone adhesive.

Compounds

GBI masking compounds are two part silicone putties. The compound is provided in two parts, "A" and "B", so that they can remain stable and usable for long durations. Typical shelf life is 2 years. Once the two parts are mixed, a moulding putty has now been created that can be used to:

- Plug holes.
- Create moulded sleeves and caps

Fabrics

Fabrics, also known as thermal spray masking blankets, are constructed from silicone coated woven fibreglass fabric. Unlike tapes, these fabrics have no adhesive. The lack of adhesive is an important characteristic which allows for the material to be reusable. The material is also highly effective for masking large areas quickly in the form of secondary masking.

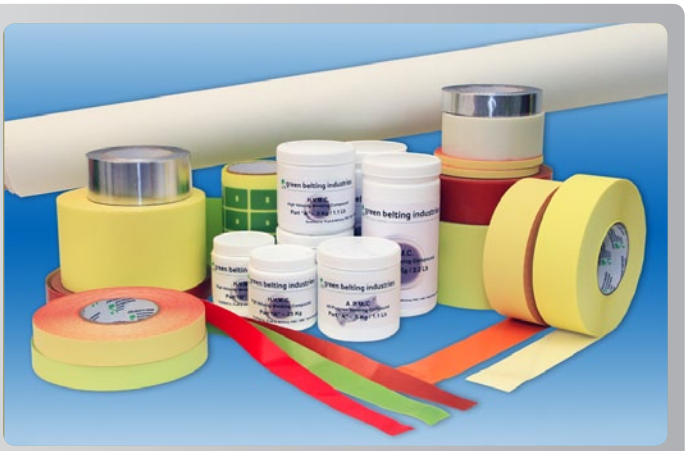
Pre-Cut or Die-Cut Pieces

Pre-cut or die-cut pieces are pressure sensitive tapes that have been pre-cut on release liners to simplify repetitive masking. Pre-cuts can be produced in sheets using PTFE Group's advanced plotter equipment. The profiles and drawings are stored in a computer (for future usage).

Pre-cut and die-cut profiles increase efficiency and safety in the workplace.

Pre-cuts are advantageous for:

- Faster masking leading to time and cost savings
- Creating a safer workplace with less razor blade handling
- Improving accuracy and consistency of masking profiles



PTFE Group provides tapes, fabrics, compounds, and pre-cut or die-cut profiles for masking in various thermal spray coating applications.

Die-cut pieces, specifically rotary die cut pieces are usually reserved for applications involving high volume repetitive masking. Rotary die cutting is accomplished at PTFE Group fabricating centers whereby rolls of tape are generated with the die cut shapes/profiles on the liner in roll form. As with the pre-cut advantages listed above, rotary die cutting is more economical for applications involving 1000's of pieces. A proper cost study should be conducted by the customer before deciding which option is most appropriate for a given situation.

Masking Methods and Techniques for Best Results

First determine if the area to be masked is considered Primary or Secondary

Primary masking is the critical masking area in direct contact with the spray particles as they impact the component surface. Primary masking is crucial as this is the area where masking and coating meet. Most operators want well defined, clean coating lines. These perfect edges can be achieved by using GBI thermal spray masking products. As a special consideration, electric arc spray poses some additional challenges for masking. Although not considered a high energy or a high heat process, the challenge comes from the wider spray pattern of the coating plume. The result is that protection of the component must also include sections further away from the primary spray area to avoid excessive overspray.

Secondary masking is the non-critical masking area that does not come in direct contact with the spray particles as they impact on the component surface. The secondary masking area is usually furthest away from the primary coating zone but operators still need to protect those areas as they can be impacted by stray spray or bounced particles. Because these secondary areas are normally larger than the primary masking area a good masking solution would improve masking efficiency (save time and money).

Product Recommendations for Wire Arc Spray Masking

Tapes

160-5s HT – Single Layer Fiberglass Tape.

160-10s HT – Double Layer Fiberglass Tape.

162-7s YL – Double Sided Fiberglass Tape.

162-12s – Double Layer Double Sided Fiberglass Tape.

170-10s YL – A reliable masking tape for most standard arc spray applications.

170-10s Green – For applications that involve higher abrasion. This tape produces cleaner coating lines and may be used with fewer layers (and less quantity) than standard tapes.

170-10s Red – Recommended for applications involving higher temperatures and longer dwell times. This tape resists burning and scorching leaving cleaner coating lines and less residue from any scorching that may occur.

170-20s YL – Double layer standard plasma spray masking tape.

170-20s Green – Double layer abrasive resistant plasma spray masking tape.

Compounds

High Velocity Masking Compounds (HVMC) – Ideal for creating reusable masking moulds, plugs, caps, & sleeves.

Fabrics

S/W 35 – White silicone coated glass fabric.

How to select the correct masking products for Primary Masking areas

To select the correct primary masking products, the operator needs to consider what factors will most affect the masking tapes, compounds, and fabrics. Wire Arc Spray coatings are generally considered to be lower energy processes; however there are several factors to consider:

Is the profile of the component intricate or basic?

Basic profiles are easier to mask and all of the GBI tapes listed in the section above will work. In many cases, operators prefer to apply two layers of masking tape to achieve a reliable primary mask. For example an operator may choose to apply two layers of 170-10s YL but to achieve time and cost savings a better option is to apply a single layer of 170-20s Green. This strategy can cut masking times by 50% and generate significant cost savings.

A turbine blade is masked with 170-10s (Red) and160 -5s (white) Masking Tapes as primary and secondary masking.

Intricate profiles are more challenging and require a good masking plan. Small, intricate parts and profiles will require a conformable (flexible) masking material: the most flexible for wire arc spray is the 170-10s YL. This product is highly conformable and will survive moderate grit blast and normal wire arc spray. If the operator is concerned about high abrasion, then 170-10s Green may be considered instead.

Does the grit blast or prep blast require coarse grit or fine grit?

All thermal spray coatings require a prep blast stage to etch the component surface so that the coating will form a strong bond. If the operator is using a fine grit of 60 or greater the abrasion will be somewhat mild. When finer grits are deployed all of the 170 series tapes, the silicone fabric, and the compound are good to use.

A cylinder masked with 170-10s (Green) Masking Tape is undergoing grit blast prior to receiving thermal spray coating.

If the operator is using coarse grits of 46 or less, we recommend using either GBI 170-10s Green or HVMT Orange. Both of these tapes will survive intense grit blast and will maintain clean coating lines as they will resist fraying. GBI products are designed to be applied only once because they survive both the grit blast and the plasma spray coating.

The final consideration for grit blast is the PSA of the grit blast nozzle. For PSA of 60 or less with relatively fine grits we expect

that all of our 170 series tapes, compounds, and silicone fabrics will survive. For PSA greater than 60 with relatively fine grits we recommend 170-10s Green. Finally, for PSA greater than 60 with grit of 46 or less, we recommend at least two layers of 170-10s Green. If the grit nears 16-24 grit other products should be considered such as GBI HVMT Orange. GBI 179-25 is also an option if flexibility is not a concern.

Is the spraying being done in a normal atmosphere or in a vacuum?

Typically Wire Arc Coatings are performed in a normal atmosphere but there are rare cases where Wire Arc Coatings are done in a vacuum. Unlike vacuum plasma spray coatings where no tapes are allowed, vacuum wire arc coatings can make use of plasma spray masking tapes (170 series tapes). Since the temperatures are still not considered extreme, products such as GBI product code 170-10s YL can work. This type of system is often used by companies producing biomedical implants.

What is the coating thickness?

Wire Arc spray coatings are applied in many different thicknesses depending on the purpose and the style of the coating. In terms of masking, one of the primary concerns is cracking or chipping of the coating as a result of "bridging" (when the coating is built up over the targeted area and the masking simultaneously). Depending on the severity, the coating may chip when the masking is removed. To avoid catastrophic bridging the operator needs to consider the coating thickness. Generally, if the coating is less than 15-18 mil the 170-10s YL, Green, or Red should work well in a single layer. Thicker coatings may require multiple 10 mil tape layers or thicker tapes such as GBI double layer tapes (170-20s YL or 170-20s Green). Another useful strategy involves the application of narrow widths of tape along the critical coating lines. After grit blasting, this sacrificial layer can be removed exposing fresh un-etched silicone rubber. This fresh surface should prevent bridging of the coating which in turn should provide a clean coating edge upon removal of the masking.

How to select the correct masking products for Secondary Masking areas

To select the correct secondary masking products, the operator needs to consider what factors will most affect the masking tapes/fabrics/compound. There are several factors to take into account:

What is the size of the secondary masking zone?

S/W 35 Masking Blanket is used as secondary masking to mask larger areas, and is re-usable.

For large areas use of the S/W 35 Silicone Coated Fibreglass (also known as a thermal spray masking blanket) is recommended. This material is a reusable form of masking that can be used to cover large areas quickly and will help to eliminate "excessive tape masking". Generally this fabric must be mechanically fastened.

Large areas with difficult profiles should utilize fabric and tape together for the most cost effective solution.

Small areas should generally use a pressure sensitive masking tape such as 160-5s HT or 170-10s YL.

Is overspray acceptable?

Depending on the work instructions, some jobs will allow for overspray. In those cases, masking in general is not needed.

Most precision jobs will not allow for over spray. In these situations, a strong and precise masking tape such as the 170 series is recommended.

Masking Strategies for Common Profiles and Components

Cylinders, Rollers, Shafts

Most rollers and cylinders have keyways which can be masked with GBI HVMC. This compound is a very quick and reliable solution for masking keyways and repetitive masking can often be created.

Journals can be masked quickly with a variety of plasma spray masking tapes or glass cloth tapes and often wider rolls are recommended for convenience. The solution involves turning the roller on a lathe and wrapping the masking using 160-5s HT (with no liner).

Large surfaces of rollers or shafts can be protected by using S/W 35 silicone coated glass fabric as secondary masking with a good quality plasma spray masking tape close to the coating area/critical area.

Reliable masking always involves 170 series plasma spray masking tape.

Fan blades

Generally fan blades are masked at the bases of the blades (blade roots). These bases can have some complex geometries that require flexible masking. We recommend using rolls of 170 series tape for masking. Pre-cut pieces can be used for repetitive complex shapes to save time and money and pre-cuts are particularly useful when targeted Wire Arc Spray coatings are directed at the tips of the blade roots.

Some operators may need to protect larger sections of the fan blade with a secondary masking application (away from the primary spray zone). For these applications we recommend using fabricated silicone fabric pouches constructed from GBI S/W 35. This application is not only a fast masking option, but often a multi-use or reusable form of masking.

Biomedical Implants

Precision masking is always required with biomedical implants. The masking material we recommend is generally a plasma spray masking tape (silicone coated fibreglass). Most operators prefer our standard 170-10s YL as the tape has exceptional flexibility allowing the masking to conform to very complex shapes. Some biomedical implants may be coated via Wire Arc Spray performed in a vacuum chamber – this process is known as Vacuum Arc Spray Coating.

Since most of the parts are small, some consideration needs to be given to excessive heat. Some operators will elect to use GBI 170-10s Red to achieve the masking for excessive heat applications associated with Vacuum Arc Spray Coating..

To improve accuracy and to speed up masking, we encourage the use of pre-cut masking profiles. The pre-cut pieces will use the material listed above, but with the required shapes already kiss cut onto a liner. This pre-cutting allows for a faster masking job with better consistency (and in a safer environment because of reduced blade handling).

Pump components

Pump components often used in the gas and oil industry are coated with corrosion resistant coatings. These coatings can be applied with the use of electric arc spray systems. Given the difficult geometries or profiles, we often recommend the standard 170-10s YL due to its conformability and very strong face-to-back adhesion.

Note that some of the coatings may require heavy etching which means intense grit blast with course grit. For the lower grit styles, we recommend two layers of plasma spray masking tape or possibly a single layer of stronger material such as HVMT Orange (High Velocity Masking Tape).

Semiconductor Components

Many semiconductor components including processing bowls are coated with forms of aluminum coating delivered by electric arc coating systems. For these applications clean coating lines are critical. For this reason, we recommend the flexible and strong 170-10s YL. For applications where abrasion is high due to grit blast, we recommend 170-10s Green to ensure clean coating lines and perfect removal of the masking.

A part receiving Arc Spray Coating

Recommendations for Heat, Abrasion, and Conformability

Extreme Heat

Generally, electric arc spray coatings are not considered an extreme heat application. Nevertheless, operators may see elevated temperatures if dwell times are long and components are small. For these applications, we recommend considering 170-10s Red if any burning is observed with standard thermal spray masking tapes.

High Abrasion

Electric arc spray coatings are generally not highly abrasive but the prep blast process prior to spraying can be very abrasive (to achieve an etched surface).

For higher abrasion applications, GBI generally recommends 170-10s Green which is a plasma spray masking tape with twice the breaking strength of competing tapes. The style of the glass is effective for maintaining the integrity of the tape leading to perfect coating lines (no fraying) and very clean removal (no adhesive residue).

While 170-10s Green is usually sufficient for high abrasion envi-ronments, GBI produces other tapes which can survive extreme abrasion (such as aluminum oxide grit less than 24 grit size). For extreme abrasion, Green Belting Industries recommends:

- GBI product 170-20s YL, a 20 mil double layered plasma spray masking tape which can take the place of the application of two layers of common plasma spray masking tape (resulting in time and cost savings).

A non-tape solution offered by GBI is our masking compound, HVMC (High Velocity Masking Compound). This two part silicone compound will withstand all forms of thermal spray coating along with surviving surface etching and blasting.

Conformability

One of the most significant challenges faced by thermal spray masking tapes is the need to be strong, yet flexible. GBI has solutions for components that are difficult to mask due to challenging geometries and profiles. GBI products will conform to the challenging profiles and will not lift during spraying while removing completely clean (leaving no adhesive residue).

The most common solution is standard plasma spray masking tape, 170-10s YL. This material uses a flat glass style that is highly comformable. This conformability combined with GBI's strong adhesion makes this product the best choice for most challenging Wire Arc Spray masking jobs involving difficult geometries.

In some cases, a non-tape solution is the best. GBI's HVMC can be used to make intricate reusable masking moulds that will take the shape of any profile. A component such as a complicated blade root would benefit from this type of masking solution.

Tape plus Metal: The Combined Solution

In terms of masking materials, there is no one size fits all solution. It is very common to use multiple masking materials for the most effective masking of a component. A common masking strategy involves a combination of Metal Masking profiles together with Tape, Compounds, and/or Fabric.

Consider that arc spray coatings present a real challenge for metal masking in terms of excessive build-up of coating on tooling and fixtures. Therefore, when operators use metal masking for arc spray they may be faced with replacing tooling or fixtures often as well as stripping coatings off of tooling and fixtures (and distorting their dimensions).
Where possible, it is often a good idea to protect tooling and fixtures in the spray booth with GBI masking materials; essentially "masking the mask".

Shadow Masking with Metal and Tape

Shadow Masking is a masking strategy whereby metal plates are used to mask off the area where a coating cannot be tolerated. While effective, shadow masking may often require tape on the component to prevent a blurry section of overspray because tape allows for precision coating lines.

Metal Masking Tooling with Tape

Often metal masking tools are designed to encapsulate a component while exposing only the areas where a coating is to be placed. Not surprisingly, the coating will build up on both the component and the masking. This can be a big problem as the coating will chip and crack when the tooling is removed. To solve this problem, thermal spray masking tape is used where the masking and component meet to act as a buffer to prevent bridging and cracking of the coating and to ensure perfect coating lines.

Strategies to Maximize Thermal Spray Masking Time and Cost Savings

Inspect the Component and Masking Prior to Spraying

Make sure proper pressure has been applied to the tape. The operator must remove all air-pockets and ripples to ensure that adhesive is fully engaged with the component surface.

If you are concerned about bridging of the coating, then we recommend prior to grit blast, using a second layer of tape (narrow strips) where the coating meets the masking. Upon completion of the grit blast, the narrow strips may be removed leaving a smooth surface that will prevent any change of bridging and cracking of the coating.

Eliminate any areas where tape is not in contact with the component, for example tape should not be used to cover holes (HVMC should be used instead).

A part masked with 170-10s Red Masking Tape, and High Velocity Masking Compound (blue) is ready for inspection prior to receiving the spray coating.

Check for surface contaminants (oil, FPI oil using a black light, grease, paint, old coating etc.).

Review coating plan to make sure the component and gun are moving to prevent excessive heat (which of course is bad for both the masking and the coating).

Make sure (where possible) that air cooling jets are engaged.

Ensure your Masking Department has the best tools for the job

Utility knives, razor blades, and/or scissors – Tapes and fabrics should be cut, not torn, as hand tearing exposes glass filaments which can become contaminants.

Masking tables with protective covers – will prevent parts from becoming scratched while also providing a surface where tape can be cut.

Lighting – All precision masking jobs require good lighting to be able to accurately mask with tapes, fabrics, and compounds.

Smoothing instrument – Most masking operators will utilize objects or tools for smoothing tape. Remember that thermal spray masking tapes are "pressure sensitive" thus they require sufficient pressure to bond well. Smoothing instruments can be fabricated plastic hand held tools and ideally have multiple surfaces to adapt to different profiles.

Rack/bar for holding tape rolls – In the interest of safety and efficiency, masking departments should have racks or bars to contain and dispense tape easily. This is the best way to store various sizes at each work station.

Don't forget these important Health and Safety considerations

Avoid cuts

Unfortunately, cuts to hands and fingers do occasionally occur. Cutting injuries result in down time (not to mention pain and possibly infection). Cuts can be reduced by employing the following:

- Pre-cut sheets of masking tape containing pre-cut profiles. Not only is this strategy safer, it also speeds up masking.
- Kevlar gloves. Where possible, employees should consider using Kevlar gloves to avoid cuts from blades and also from sharp component areas.

Avoid repetitive motion disorders

Some companies perform masking of repetitive shapes. Peeling the liner off of thermal spray masking tapes can sometimes lead to repetitive motion injuries (particularly if breaks, rest periods, or job rotations do not occur). This problem is more often seen with operators who consistently use wider width rolls of masking tape such as 4" and greater. To reduce this potential for injury, GBI recommends pre-cut masking profiles to minimize liner removal and avoid excess strain on wrists. Furthermore, most masking operators are moving towards narrower width rolls such as 2" wide to help reduce repetitive motion disorders.

Use of pre-cut masking profiles for repeat masking profiles reduces the risk of repetitive use injury.

Contain release liners to minimize trip and fall hazards

Masking departments should be kept clean, especially the floors. Unfortunately, many shops forget to immediately dispose of release liners (which are discarded after the tape is unwound). A good practice is to have several garbage containers beside the masking work space to prevent release liners ending up on the floor which can lead to slipping hazards. This potential hazard is especially common when customers use products with clear polyester release liners (they are very slippery and harder to see compared to yellow PVC release liners).

Additional tips for successful masking

Never hand tear thermal spray masking tapes

Avoid hand tearing even though some thermal spray tapes may have weaker breaking strength. Always use scissors or a utility knife to precision cut tape. Thermal spray masking tapes utilize

a base of woven fibreglass and when torn by hand, the fibreglass is exposed as a potential contaminant to the coating. The frayed glass can also shadow the coating line, leading to rework.

Always apply firm pressure to ensure strong adhesion of the tape to the component.

Thermal spray masking tapes are pressure sensitive, meaning they require force to properly wet out and adhere. A smoothing tool or instrument (even fingers) should be used to create a good bond of the tape to the component.

Avoid the use of solvents.

Where possible solvents should not be used on thermal spray masking tapes or the components to be masked. Strong solvents can break-down and liquefy the adhesives and silicone rubbers. For example, if a strong solvent is used and tape is immediately applied to that surface, the tape will not adhere well.

Mild solvents can be used to clean a surface prior to applying the tapes, however the operator should make sure that the solvent has flashed off before applying the tape.

Never allow for silicone adhesive tapes to freeze but refrigeration is okay.

Freezing of silicone rubber tapes may interfere with the chemistry of the product, lead to poor adhesion values, and does NOT extend the life of the product.
Refrigeration of tapes will not have a negative effect on thermal spray masking tapes.

Best storage conditions are at room temperature, but avoid excessive humidity and excessively dry storage.
When using GBI tapes, they can become contaminated by dirt and dust particles.

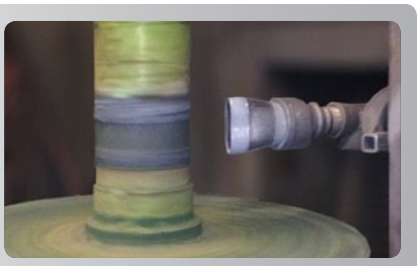
These particles can reduce the tack and adhesion of the tapes as well as potentially becoming a contaminant to the coating. A clean working environment is important.

Where possible, try to avoid narrow strips of masking tape less than ¼" wide.

Tapes can be manufactured in widths of less than ¼", however, operators risk tape lifting due to small surface coverage (adhesive coverage) versus the relative force of the spray. In other words, extremely narrow strips of tape have a better chance of lifting, tearing, or moving compared to strips of tape that are ¼" or greater in width.

Engage forced air cooling to control the surface temperatures where possible.

Remember that temperatures beyond 500° F (260°C) will break down silicone tapes, compounds, and fabrics. The higher the temperature beyond 500°F (260°C) the faster the break down will occur.



Air cooling reduces substrate temperature and increases masking performance.

Thermal Spray masking products cannot be used for applications such as VPS (vacuum plasma spray)

The only suitable masking material for VPS would be constructed from solid metal.

As with other coating styles, twin wire arc spray masking has varying degrees of challenge depending on factors such as profile of the component, size of the component, coating thickness, coating style, etc. GBI has produced many different options (not just tapes) to solve a variety of masking challenges related to twin wire arc spray coatings. The goal is to mask faster, safer, and more accurately resulting in time and cost savings.

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