

Designing a custom rubber part that requires bonding to a metal component can be very challenging. The most important issues that need to be well understood and designed is first of all the determination of rubber together with the determination of the substrate and follows the determination of the bond type, which can be a chemical bonding with hot vulcanized adhesive, a gluing process after vulcanization or just a simple encapsulation.

Sometimes there is some latitude during the design phase to consider a number of different substrates or materials for mating parts.

M. I. Panagiotarakos & Co. is not an expert in materials like steel and plastic, but we can be helpful in understanding any challenges or restrictions that particular materials may present if used in bonding to rubber.

For example, rubber needs to be vulcanized at temperatures above 145 degrees Celsius. This requires that any substrate chosen for chemical adhesion must be able to survive that temperature for an extended amount of time, which excludes a lot of plastic materials such as Polypropylene and Polystyrene. These low-melt plastics can be bonded to rubber after vulcanizing with special cyanoacrylate adhesives or can also be designed to mechanically “bond” or mate with a rubber component.

RUBBER TO METAL BONDING

Generally, if plastic is going to be used as the substrate, it must be a glass-filled nylon material with a higher melt temperature.

Another issue to consider when choosing a substrate is what will be required to prepare the substrate for molding. Many untreated metals are susceptible to rust which can inhibit bonding and contaminate rubber during the molding process. Then again, some metal treatments are too smooth to allow for good chemical bonding and may need to be sandblasted or roughened prior to molding and bonding.

Finally, if the substrate is not going to be fully covered with rubber, thought must be given to how to protect the surface finish of the uncovered metal during the manufacturing process which includes heat and metal-to-metal contact when the insert is placed in the mold.

Once the rubber and metal type or substrate are defined, the type of bond or union has to be considered. Issues to consider when making this decision are cost, strength of bond required, direction of force or impact relative to rubber to metal bonding or rubber to substrate unions.



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ENCAPSULATION OR MECHANICAL LOCK

Oftentimes the most elegant and cost effective solution is encapsulation or a designed mechanical lock. Encapsulating metal with rubber requires that the metal/substrate have either a through-hole or some sort of positive feature that the rubber can mold around like a knob or neck. This technique is also used for many rubberized bolt heads. For this to be successful, the substrate has to be able to handle the molding temperatures, which can limit the choices of plastic and possibly limit some metal coatings.

M. I. Panagiotarakos & Co engineering and sales team have years of experience and have worked with countless customers developing innovative ways to ensure rubber and metal parts stay connected without the added cost of adhesive. Depending on the size of the part, eliminating the need for chemical adhesive can save 20% or more of the total cost. Additionally, when no adhesive is used, the metal inserts can easily be reclaimed, and remolded which reduces the costs associated with scrap and bad pieces.

CHEMICAL BONDING WITH ADHESIVE

When the bond between rubber and metal is absolutely critical and involves complex geometry or is a very large

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or very small area, chemical bonding is likely the only choice. One advantage of this type of bond is that it extends over the entire surface of contact between the rubber and metal. When done correctly, this type of bond also exceeds the tear strength of the rubber, meaning that the rubber will tear before the bond fails; chunks of rubber will remain adhered to the metal if the two are separated.

One disadvantage of chemical adhesion is cost. There is the additional cost of the metal preparation and the adhesive application. If there is any scrap, the additional cost of either scrapping the metal insert or reclaiming the insert, which is a multistep process.

GLUING AFTER VULCANIZATION

There are some instances when gluing rubber to metal or plastic as a secondary operation is the best option.

This is particularly true when the metal is a casting that is not precision machined. In the case of a rough casting, the dimensional tolerances are not tight enough for the inset to be placed into a mold and clamped under pressure - which is required when using the first two bonding techniques.



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ADHESION TESTING

In the most aggressive environments, the bond between rubber and metal, or rubber and plastic, should be stronger than the tear strength of the rubber. While there are defined ISO standard tests for checking adhesion, these rely on bonding a thin strip of rubber to a thin strip of metal or plastic and then using test equipment to peel or pull the two materials apart. The advantage of these tests is that there is a specific, numeric result which is the force at which the bond fails. While these tests can be somewhat helpful for adhesive and material development, they do not generally help confirm good bond on finished product.

M. I. Panagiotarakos & Co. has developed a number of different ways to test rubber to metal bonded parts. Sometimes these tests are destructive and can be done with a hydraulic press that applies or records pressure applied.

M. I. Panagiotarakos & Co has years of experience bonding rubber to metal. We have been involved in projects that use all types of rubber, all types of substrates (plastic and metal), and all types of bonding as described above. No matter what your application requires M. I. Panagiotarakos & Co can help to
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