Dyneon™ Fluoroelastomers
Adhesion Information

Metal Preparation

Metal Preparation
A very important step in the bonding procedure is cleaning of the substrate surface. For metal, vapor degreasing or alkali washing is typically used to remove surface oils that are often present to protect the metal from corrosion.

Following a thorough cleaning of the substrate surface, a mechanical or chemical treatment of the surface can further enhance metal adhesion. Examples include:

1) grit blasting (40-60 mesh alumina grit recommended)
2) phosphate conversion coatings (micro or macrocrystalline zinc phosphate or iron phosphate)
3) acid etching

For grit blasted parts, degrease parts again after grit blasting and wash if needed to remove grit or dust.

Parts should be dried and stored in sealed containers to protect from contamination by moisture, dust, oil, etc.

Adhesives/Primers

There are several solvent and water based primers developed specifically for fluoroelastomer bonding. Some common types include the following:

**Solvent Based**
- Chemlok™ 5150 - Lord Chemical Company
- Thixon™ 310 - Morton International
- Megum™ 3290-1 - Chemetall GmbH

**Water Based**
- Chemlok 610
- Thixon 3010
- Megum W3293, W3295

Adhesives can usually be applied by dip, spray, or brush methods. When using solvent based adhesives listed above, it is sometimes beneficial to dilute the adhesive with methanol or ethanol to avoid excessive primer thickness. This is often the case when applying the primer by dipping or brushing. Common dilutions are 1:1 up to 5:1. For metal to primer bond failures, prebaking of the primer may be of help. A 15 minute at 177°C (350°F) prebake is recommended if a prebake is warranted.
Compounding Fluoroelastomers

Modifying the fluoroelastomer compound to improve or enhance its adhesive characteristics is an option available to the fluoroelastomer compounder. Below are five aspects that should be considered when compounding fluoroelastomers.

**Polymer Type**
In general, the greater the fluorine content of the polymer, the lower the bondability. However, successful bonding to metal is possible with copolymers and terpolymers.

**Curing System**
There are three main types of cure systems used for fluoroelastomers. These include diamine, bisphenol and peroxide cure types. While all three can readily be bonded to metal, some are more sensitive to compound formulation and substrate preparation than others. The diamine type system provides the best adhesion to metal. However due to processing and property limitations of this type of cure system, it is not widely used in the industry. The most common type of cure system is the bisphenol type. Bisphenol cured compounds can readily be bonded to metal but is more affected by compounding variations than the diamine type. The peroxide cure system is the most difficult to bond. However with proper compounding, good adhesion can be obtained with any of the fluoroelastomer cure systems.

**Fillers**
The most common reinforcing filler used in fluorocarbon elastomers is medium thermal (MT) carbon black. This is also known as ASTM N-990 or N-991 type black. MT black provides the best balance of mechanical properties and the best adhesion properties compared to furnace or channel type carbon blacks.

If more reinforcing carbon blacks are needed to obtain certain desired mechanical properties, it may be of help in blending with MT black to a level where good bond is obtained. Test results indicate good bond can be obtained if at least 1/3 of the carbon black used as filler is MT black.

Mineral fillers such as calcium silicate, diatomaceous earth, ground silica, mineral blacks, and metal oxides have also been found to provide excellent metal adhesion in fluoroelastomer compounds.

High and low filler loading resulting in high and low hardness (>85 and <65 Shore A) tend to be more difficult to bond than compounds in the mid-hardness range. Special tie coats (discussed later) may be beneficial in these cases.

**Metal Oxides**
A typical bisphenol cured fluoroelastomer compound contains a combination of magnesium oxide and calcium hydroxide in a 3 and 6 phr level respectively. Although this ratio is normally satisfactory, improvements in adhesion can be obtained by reversing the ratio or increasing magnesium oxide level to 9 parts or even higher.

Calcium oxide can be used in place of or in addition to magnesium oxide to greatly improve metal adhesion 3-phr calcium oxide is usually adequate although higher levels can be used for extremely difficult to bond applications.

Lead oxide (litharge) is often used in fluoroelastomer compounds to improve water and steam resistance. Lead oxide will adversely affect metal adhesion and should be avoided where a good cohesive bond is needed. If lead oxide is required, the adverse effects may be offset by the addition of higher levels of magnesium oxide or calcium oxide.

Keep in mind that the use of metal oxides to improve adhesion as described above will have an affect on other properties as well. Cure rate, compound viscosity, compression set resistance, water swell, etc. are some of the properties that may be affected.

**Processing Aids**
If processing aids are required, such as carnauba wax or polyethylene, levels less than 2 phr are recommended. Since these materials will effect bond strength, their use should be minimized. The use of external mold release agents must be held to a minimum. Any material that may form a film between the fluoroelastomer and the adhesive should be held to a minimum or avoided.
**Tie Coat**

In some instance where these various compounding approaches have not improved the adhesion of the fluoroelastomer compound, the use of an adhesive tie coat may be necessary. A tie coat is a fluoroelastomer solution coating that is applied as a second adhesive coat over the primer. The substrate is prepped, primer applied and allowed to dry. Then the tie coat is applied and allowed to dry thoroughly before molding. The following is a typical formula for a tie coat.

**Tie Coat Formula**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyneon FC 2230 (low to medium viscosity raw gum)</td>
<td>100</td>
</tr>
<tr>
<td>Magnesium oxide (low activity grade)</td>
<td>15</td>
</tr>
<tr>
<td>N-990 Medium Thermal Carbon Black</td>
<td>20</td>
</tr>
<tr>
<td>Diak™ #9 (Blocked diamine curing agent)</td>
<td>1.5</td>
</tr>
</tbody>
</table>

**Curing of Metal Bonded Parts**

Cure rate of the fluoroelastomer can be an important factor in successful metal bonding. Cure rate can be affected by the fluoroelastomer formulation and molding temperature. If bonding problems exist, it may be beneficial to reduce the cure rate by lowering mold temperature or adjusting compound formulation.

Most fluoroelastomer compounds also require a secondary post cure to obtain ultimate properties. Improvements in adhesion are usually obtained after this post cure step. If poor adhesion is obtained it might be beneficial to reduce the post cure temperature. A maximum temperature of 232°C (450°F) is generally recommended. A step or ramped post cure starting at 125°C (257°F) and gradually increasing to the maximum post cure temperature may also be of benefit especially for thick cross section parts.

This has been a brief summary of methods commonly used in improving metal adhesion of fluoroelastomer compounds. There are many more variables to consider that make each situation unique. Such variables include type of molding, compound viscosity, molding pressure and special formulations. Please contact your technical service representative if adhesion problems are encountered.
ISO 9001/QS-9000
All Dyneon™ fluoroelastomers are manufactured at ISO 9001 registered facilities. Dyneon fluoroelastomers produced in North America are manufactured at QS-9000 registered facilities.

Safety/Toxicology
Follow recommended handling precautions for use of Dyneon fluoroelastomers. General handling precautions include: (1) Store and use all Dyneon fluoroelastomers only in well ventilated areas. (2) Do not smoke in areas contaminated with dust from Dyneon fluoroelastomers. (3) Avoid eye contact. (4) After handling Dyneon fluoroelastomers wash any contacted skin with soap and water.

Potential hazards including evolution of toxic vapors, do exist during compounding or processing under high temperature conditions. Before processing Dyneon fluoroelastomers, consult the product MSDS (Material Safety Data Sheet) and follow all label directions and handling precautions. You should also read and follow all directions from other compound ingredient suppliers. Material Safety Data Sheets on Dyneon products are available from your Dyneon Sales Representative or by dialing 651-733-5353.

Technical Information and Test Data
Technical information, test data, and advice provided by Dyneon personnel are based on information and tests we believe are reliable and are intended for persons with knowledge and technical skills sufficient to analyze test types and conditions, and to handle and use raw polymers and related compounding ingredients. No license under any Dyneon or third party intellectual rights is granted or implied by virtue of this information.

Important Notice:
Because conditions of product use are outside Dyneon’s control and vary widely, user must evaluate and determine whether a Dyneon product will be suitable for user’s intended application before using it. The following is made in lieu of all express and implied warranties (including warranties of merchantability and fitness for a particular purpose): If a Dyneon product is proved to be defective, Dyneon’s only obligation, and user’s only remedy, will be, at Dyneon’s option, to replace the quantity of product shown to be defective when user received it or to refund user’s purchase price. In no event will Dyneon be liable for any direct, indirect, special, incidental, or consequential loss or damage, regardless of legal theory, such as breach of warranty or contract, negligence, or strict liability.