

ETCHING OF FLUOROPOLYMERS

Etching is a process of preparing the surface of a fluoropolymer insulated wire or tubing for bonding to another material.

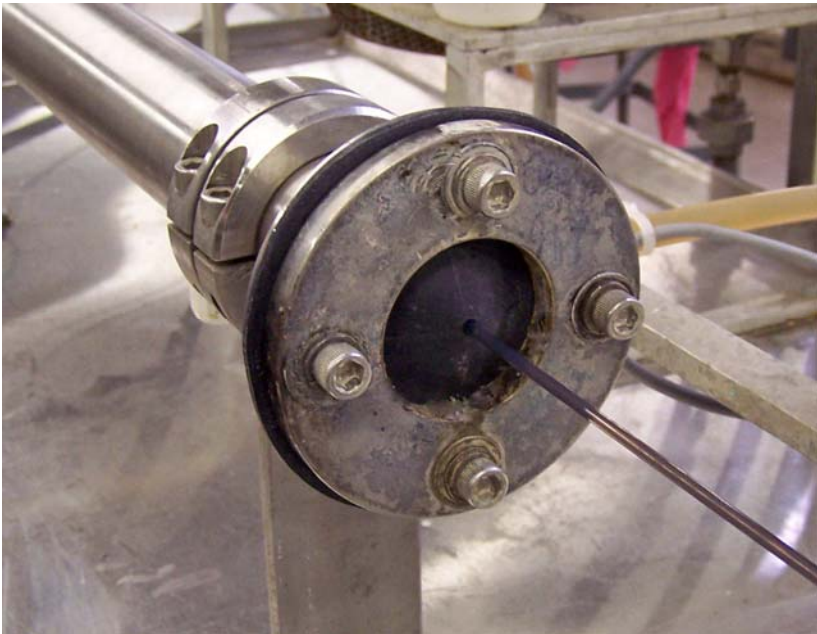
The etching process is used on PTFE, FEP and PFA fluoropolymers. It is most effective on PTFE. PTFE is primarily noted for its superb thermal, electrical and chemical resistance characteristics. High lubricity and non-stick properties combined with high temperature resistance make PTFE the choice in applications such as coating of non-stick frying pans. Markel takes advantage of these characteristics in the production of ARTM abrasion resistant liners for push pull control cables. It is necessary to defeat the surface lubricity of PTFE when an application requires a bonded jacket on tubing or the sealant potting of insulated wire.

The periodic chemical structure of PTFE (see CHEMICAL STRUCTURES OF FLUOROPOLYMERS) results in a non-polar, non-wettable surface. The etching process strips a layer of fluorine atoms from the surface and leaves the carbon atoms with a deficiency of electrons. When the altered surface is exposed to the atmosphere, oxygen and hydrogen restore some of the electrons forming a surface that will accept bonding. The altered surface darkens to a tan to brown color. The depth of color is not a measure of the effectiveness of the etch. The depth of the etch is only a few angstroms. Therefore, the physical properties of the PTFE remain mostly unaffected.

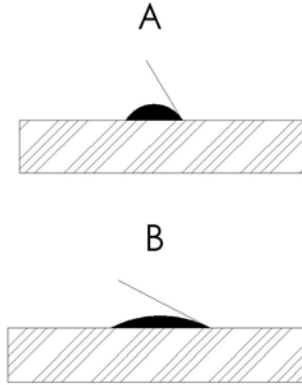
The tubing to be etched enters the chemical chamber.



The etched tubing exits the chamber. Note the darkened surface.



The effectiveness of the etch is measured by evaluating the change in surface wettability. Wettability is evaluated by measuring the contact angle of a droplet of water on the surface of the material. The illustration shows the angles measured on droplets of water. The smaller angle (B) indicates a surface that is more wettable and therefore would allow a more effective bond to be achieved.



Shelf life of etched material is basically unlimited if precautions are taken in storage. Etched fluoropolymers will continue to pull electrons from the atmosphere to repair the deficiency. This process eventually will compromise the effectiveness of the surface to accept a bond. The surface is also affected by ultraviolet light.

The etched tubing is covered with black plastic for storage.

