

## PFA Liner Durable Under Any Process Condition

### The superiority of PFA to PTFE as a liner material

#### Why Yokogawa uses PFA in AXF series flowmeters

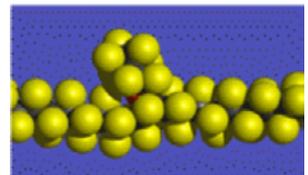
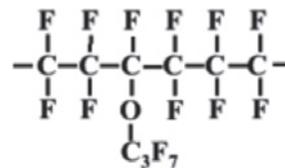
In its magmeters, Yokogawa employs liners made of perfluoroalkoxy (PFA) resin. PFA offers equivalent heat and chemical resistance as PTFE, but additionally the material flexibility enables injection molding. PFA is used mainly in chemical plants and in semiconductor manufacturing equipment. Super PFA, which offers lower wash-out of fluorine ions and particles, is widely used in the semiconductor industry. Yokogawa uses the highest grade Super PFA, resulting in further improvements for a smoother surface and increased permeation resistance. As demonstrated by in-house tests using a 35% hydrochloric acid solution, Super PFA delivers approximately three times the permeation resistance of conventional PFA.

#### Comparison of PFA and PTFE

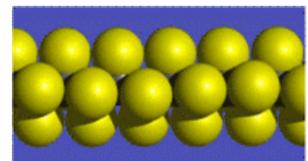
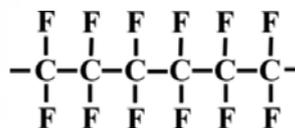
In general, all surfaces inside a magmeter, with the exception of the electrodes, must be lined with insulating materials (liner). There are many kinds of liner materials, and the performance of

magmeters largely depends on these materials. Fluoropolymers are considered the most versatile among the various liner materials, and PFA and PTFE are the two main fluoropolymers used as liners in magmeters. Although

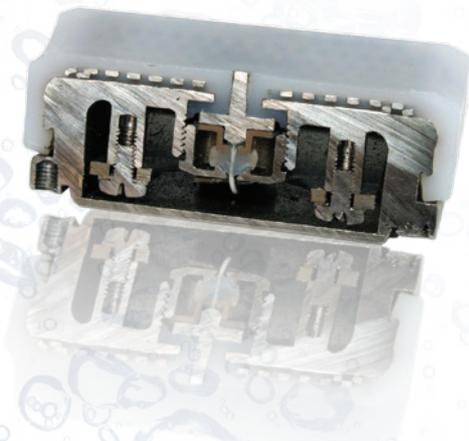
PFA and PTFE have almost the same corrosion resistance, PFA offers far superior performance compared to PTFE as a liner. PTFE cannot be used for an injection molding process due to its high melt viscosity and low heat flowability. When used in magmeters, PTFE is either “bonded” to the inner surface of the flowtube by mechanical fit or by bonding adhesives. Pin holes also tend to form in PTFE, and therefore it has weaker corrosion resistance than PFA. With injection molding, PFA can form stable layers without pin holes, thus it is the ideal liner material for magmeters, offering superior corrosion resistance at high temperatures.



[Molecular architecture of PFA]



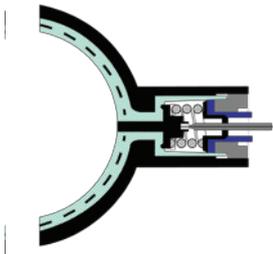
[Molecular architecture of PTFE]



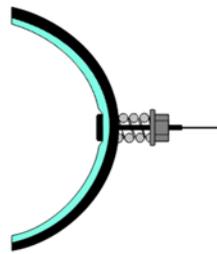
### Construction

#### Advantages of PFA versus PTFE

With injection molded PFA, the sealing structure of electrodes can be significantly improved. As shown in the following figures, any process fluid that permeates the liner does not reach the electrode room as its wall is also protected by the PFA liner. With a conventional PTFE liner, only internal insertion type electrodes can be used. As a result, process fluid that permeates can reach the electrode compartment and cause signal deterioration.



Construction of the electrode for PFA liner



Construction of the electrode for PTFE liner

#### PFA superiority under negative pressure

In order to securely affix the PFA liner to the inner surface of a flowtube, a metal retaining plate, called punched plate, is welded to the inner pipe surface and then the PFA resin is injection-molded onto it. As a result, PFA resin enters each hole, and the lining is securely fixed with the flowtube. In contrast, the PTFE liner easily delaminates under negative pressure because it is only bonded to the surface.



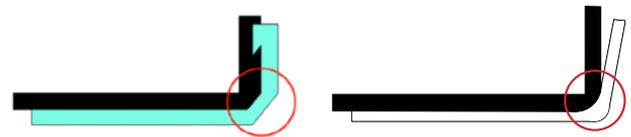
Structure of metal retaining plate for PFA liner



Deformed PTFE liner

#### Comparison of liners under abrasive process conditions

While fluoropolymer liners are not always ideal for use with slurries, they are often used in slurry and corrosive applications such as those typically found in the pulp and paper industry. As shown below, the PFA liner withstands strong abrasion. The difference is that, with injection molding, the thickness of the PFA liner can be increased along the edges. In contrast, the PTFE liner is a tube of uniform thickness that is bonded to the pipe, and it tends to break away entirely, starting at the edges.



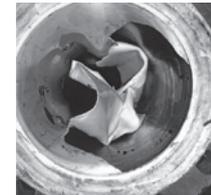
PFA Liner at an edge

PTFE Liner at an edge

Below pictures show damaged magmeters liners. In case of PFA, the abrasion to liner occurs gradually, thus measurement continues. In case of PTFE, the measurement stops once it fails. Moreover leakage will occur and cause danger to the operation.



PFA Liner



PTFE Liner

#### Conclusion

With their PFA liners, Yokogawa's magmeters demonstrate superior material characteristics, and this highly reliable construction enables stable process measurement for customers.