

Types of Fluorinated Elastomers

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ASTM D 1418 provides guidance on the nomenclature and description on fluorinated elastomers. The major classes as defined by ASTM D 1418 are FKM, FEPM, and FFKM. The FKM polymers are divided further into five types. While helpful as a general description material composition, this classification system does not fully describe each polymer based on important characteristics of fluid and temperature resistance. Monomer composition, monomer sequence, and cure system are additionally important. Each of these characteristics imparts particular advantages including chemical and fluid resistance, physical properties, and the temperature performance range. The wide variety of polymers and compounds available on the market can easily confuse an engineer trying to determine the best material for a particular environment. An experienced [rubber technologist](#) should be consulted for assistance in material selection for your sealing application.

FKM

Fluoroelastomers, FKM, are a diverse group of polymers based on the polymerization of a few monomers. The monomers of VF₂, HFP, TFE, and PMVE are the basis of nearly all commercially available fluoroelastomers. The copolymers deriving from the polymerization of VF₂ and HFP, broadly defined and as a FKM type 1, and typically have a fluorine content by weight of approximately 66%. In FKM type 2, termed a terpolymer, the TFE addition to the monomer composition variably increases the fluorine content between 67% and 70%, depending on the polymer grade.

The higher fluorine content of a terpolymer compared to a copolymer is not without compromise. Chemical resistance improves in a terpolymer but the low temperature performance decreases. This leads to the need for an FKM with improved fluid resistance and low temperature flexibility.

FKM type 3 is composed of VF₂, TFE, and PMVE. The addition of PMVE (& reduction of HFP) to the polymer backbone improves low temperature flexibility and sealing performance at low temperature. A wide range of FKM grades are available optimized for properties such as low temperature performance or fluid resistance. Most of the commercial grades of low temperature FKM fall into the category of FKM type 3.

FKM type 4 is composed of the monomers VF2, TFE, and Propylene. FKM type 4 is used in a few specialized automotive applications.

FKM type 5 is more base resistant than other FKM types. FKM type 5 is composed of the monomers of VF2, HFP, TFE, PMVE, and ethylene. FKM type 5, while being more base resistant than other FKM types, is not recommended for very high pH environments of 10 and higher for long term service.

Two cure systems further define the types of fluoroelastomer although not explicitly defined in ASTM D 1418. Ionic cured (Bisphenol AF, BAF) and peroxide cured FKMs are the most frequently used cure systems. BAF cure systems are nearly exclusive to copolymers. FKM compounds with a bisphenol cure system have the highest thermal resistance and compression set resistance. FKMs with increasing fluorine and PMVE content on the polymer backbone have fewer available cure sites for the bisphenol cure system mechanism. An alternative cure system is needed to achieve a desirable cure state and peroxide cure system is used. Normally a halogen-containing cure site monomer (Br or I) is added to the polymer chain ends. The cure site monomer (CSM) is available for cross-linking with triallyl isocyanurate (TAIC). The peroxide cure system is more chemically resistant than bisphenol cured systems.

All FKM Types 1 through 5 are known to be highly susceptible to attack by strong nucleophilic agents such as amines. Peroxide cure, type 4 FKM and type 5 FKM compositions improve resistance to amines but are not completely resistant. Resistance to methanol varies significantly among different FKM compositions.

FEPM

The FEPM class of fluorinated elastomers is composed of the monomers of Propylene and TFE (TFE/P) or Propylene, TFE, and PMVE (ETP). FEPMs are normally peroxide cured. FEPMs by definition have no VF2 which prevents chemical attack from bases and amines. FEPMs are well suited for oil and gas applications where amine corrosion inhibitors are used and in high pH environments. FEPMs are well suited in automatic transmission fluid (ATF) and automotive coolant sealing applications. Low temperature flexibility is not very good and must be considered when FEPM seals are used in cold environments. TFE/P FEPM compositions significantly swell in aromatic hydrocarbons and should not be used in these fluid environments.

FFKM

Perfluoroelastomers, classified as FFKMs, are fully fluorinated and are the most high temperature and chemically resistant polymers based on the monomers TFE and PMVE. By definition, perfluoroelastomers have no hydrogen on their backbones and are not susceptible to chemical attack by most chemical species. The polymer backbones of FFKM polymer are all similar but the cure chemistry and cure sites do create difference in performance among different compounds. The compounding of FFKMs is very important and the poor selection of fillers and cure systems can undermine the performance of the compound in a seal. Only a few companies have the expertise to develop FFKM compounds and manufacture FFKM parts. [Perlast FFKM](#) is a widely used and trusted brand of perfluoroelastomer parts.

Contact

For questions about your high performance sealing application, please contact us at the telephone or website below. We are located in New Jersey, USA.

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