As a result, EBA/MDH based compounds –Lucofin® 7440 HFFR- can be processed up to +- 220 °C whereas ATH based compounds -7410 Lucofin® HFFR and standard EVA/ATH compounds- can be processed only up to 160 °C – 170 °C. Depending on the design of the extrusion line Lucofin® 7440 HFFR enables an increase of production output of at least 30 % due to its significantly elevated processing temperature (see figure 10).

This is essential because in many cable designs the highly filled HFFR compounds represent the bottle neck limiting line speed. Lucofin® 7440HFFR offers an attractive solution to overcome this issue.

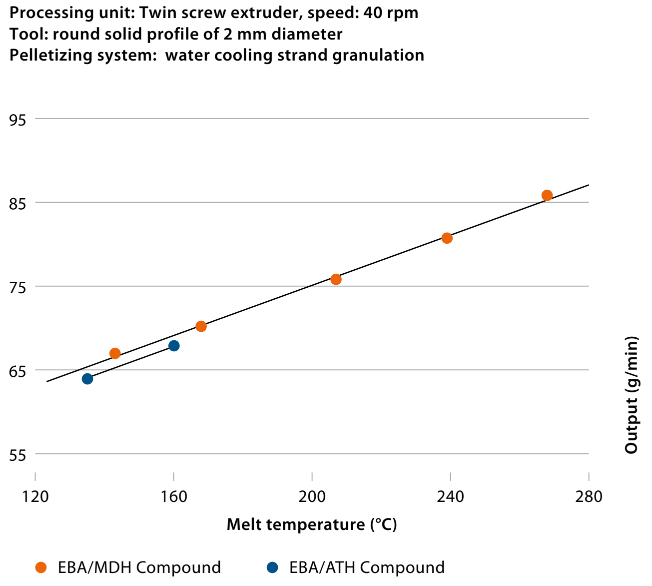


Figure 10: Output of HFFR compounds based on EBA/ATH Compound and EBA/MDH as a function of melt temperature

PROCESSING STABILITY

Many HFFR grades based on EVA/ATH are prone to processing instabilities, such as surging, whereas EBA based compounds are very stable in that respect. Figure 11 shows the rheology curve for Lucofin® 7410HFFR, Lucofin® 7440HFFR and for a standard EVA/ATH compound.

The often observed surging of EVA/ATH compounds -to be seen at ca. 5.00 e2 bar in figure 11- may result in fluctuations of layer thickness during cable production and the eventual need for more material to compensate for these fluctuations. Opposed to that, EBA based compounds -Lucofin® 7410HFFR and Lucofin® 7440HFFR- can be processed very smoothly and offer the potential for using less material due to only minor fluctuations in cable thickness.

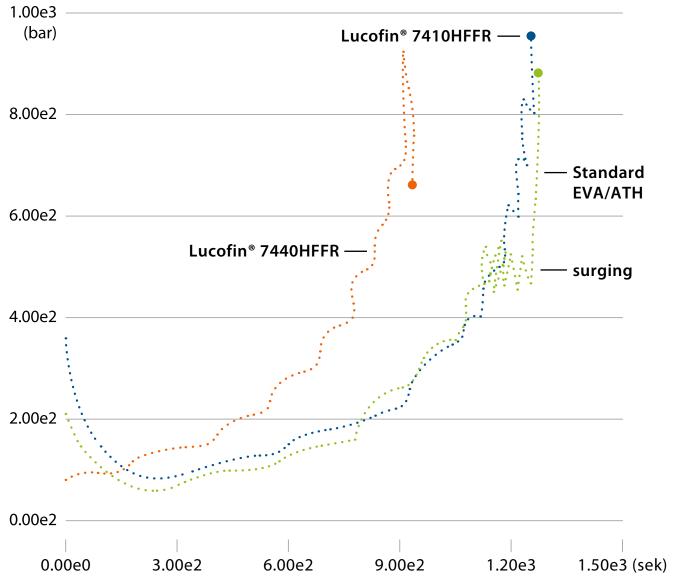


Figure 11: Rheology curve for Lucofin® 7410HFFR, Lucofin® 7440HFFR and for a standard EVA/ATH compound

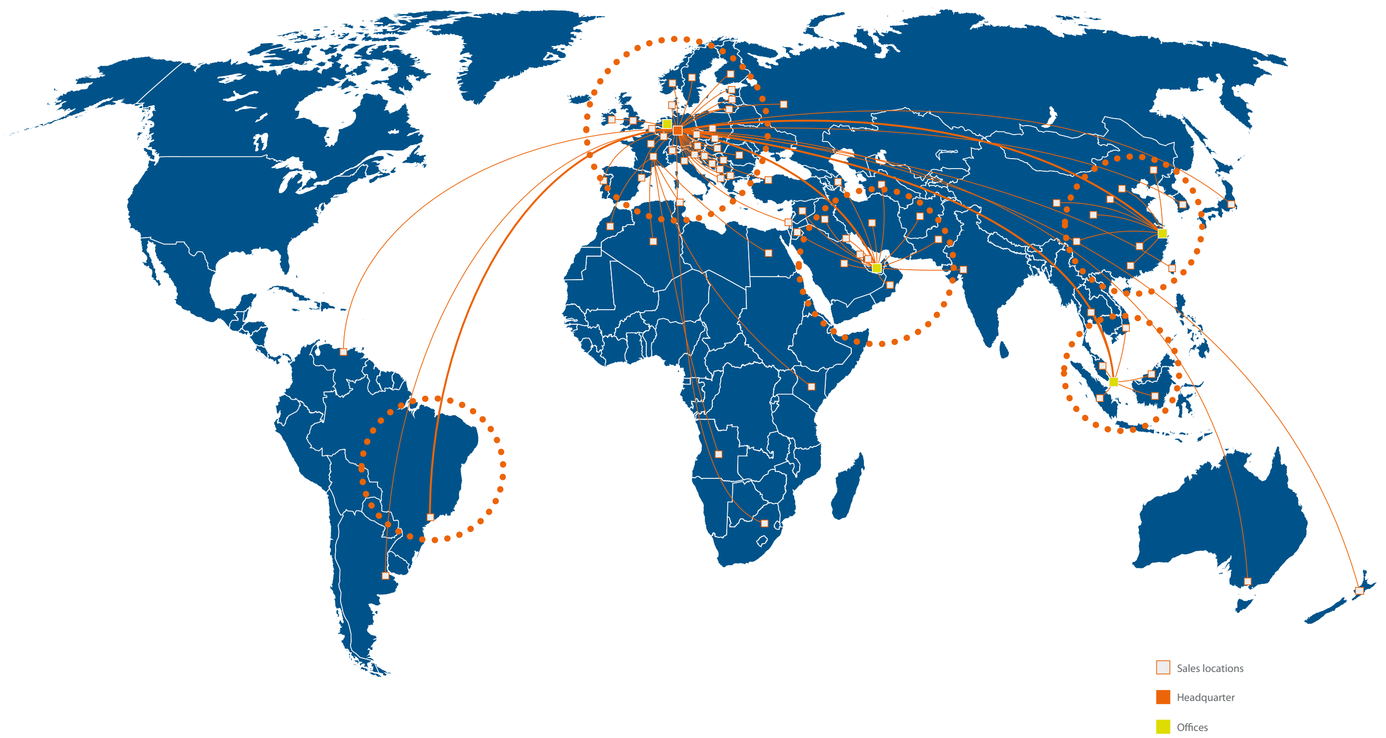
SUMMARY AND CONCLUSION

In summary, it can be concluded that EBA based Lucofin® 7410HFFR and Lucofin® 7440HFFR have the following advantages as compared to traditional HFFR grades based on EVA/ATH:

+ Very low water absorption and only little drop of electrical and mechanical properties after water storage: suitable for cables in wet areas
+ Excellent low temperatures flexibility: suitable for cables in cold areas
+ Good ageing properties: suitable for cables in hot areas
+ Increased production output for Lucofin® 7440HFFR: suitable for high line speed cables
+ Superior processing stability avoiding issues like surging during cable extrusion and resulting in very few fluctuations of layer thickness therefore offering the potential for using less material

LUCOBIT
THERMOPLASTIC POLYOLEFINS

LOCATIONS



LUCOBIT Aktiengesellschaft
Basell Polyolefine GmbH / Brühler Str. 60 • B100
D-50389 Wesseling
Phone +49 2236 / 37859-0
Fax +49 2236 / 37859-99
info@lucobit.de
www.lucobit.de

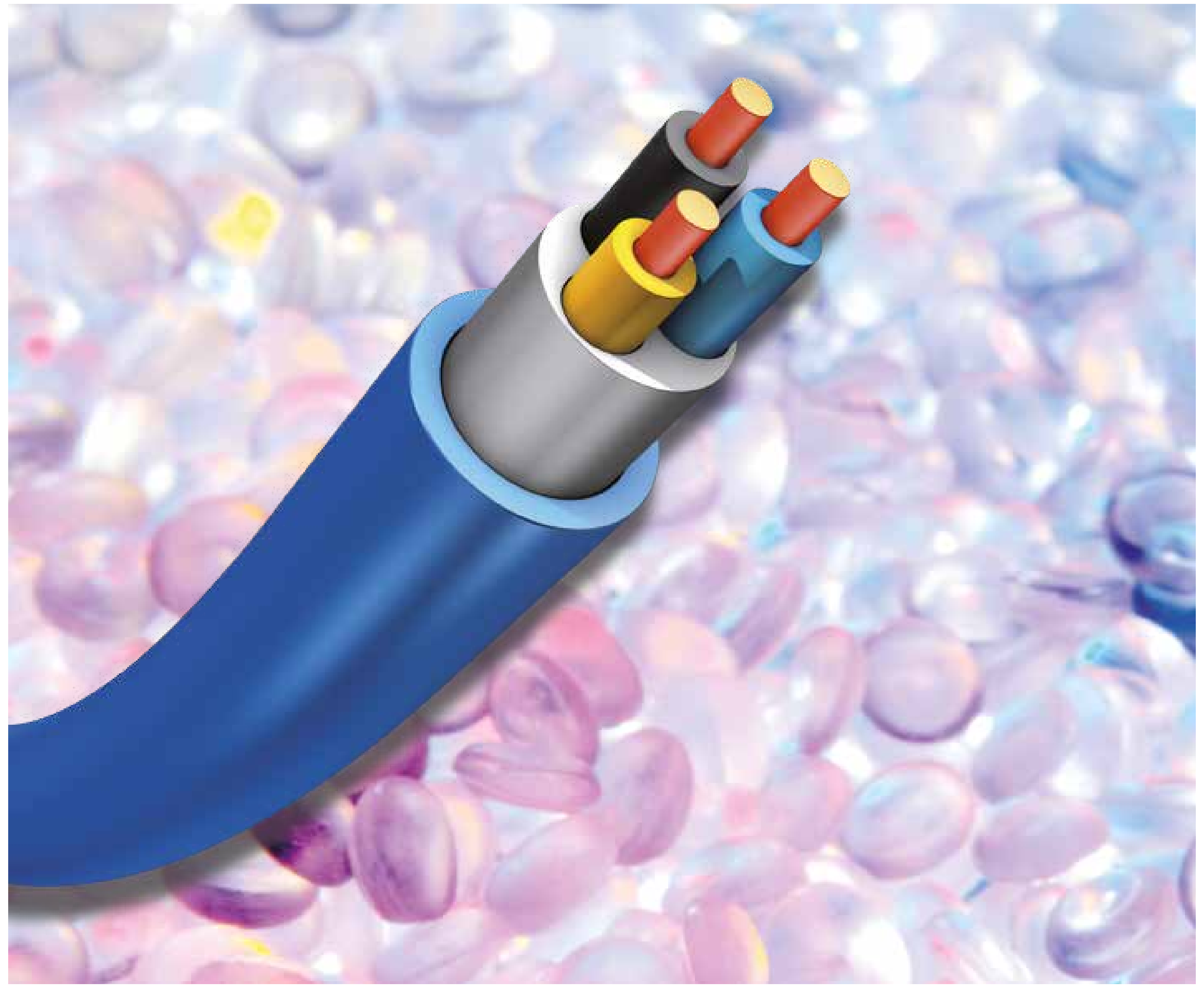
LAG_HF_1013

LUCOBIT
THERMOPLASTIC POLYOLEFINS

FLEXIBLE POLYMERS

WIRE & CABLE GRADES

LUCOFIN® 7410HFFR AND LUCOFIN® 7440HFFR



... we make better polymers

LUCOBIT HFFR WIRE & CABLE COMPOUNDS BASED ON ETHYLENE BUTYL ACRYLATE

PRODUCTS – THAT MAKE YOU SUCCESSFUL

GENERAL

Halogen Free Flame Retardant (HFFR) compounds are a relatively new class of materials substituting more and more PVC compounds in cable applications. This trend follows consumer demands as well as legislative pressure.

HFFR Compounds have the following characteristics:

- Low smoke generation
- Non-corrosive gases
- Very good dielectric properties
- Recyclability

Especially if security of people and protection of values are of concern the use of HFFR compounds is requested. Hospitals, energy stations, chemical and off-shore industry –as shown on the cover page- are just some target markets.

LUCOBIT developed HFFR grades based on ethylene butyl acrylate (EBA) and aluminium tri hydrate (ATH) –Lucofin® 7410 HFFR- as well as based on ethylene butyl acrylate (EBA) and Magnesium di hydrate (MDH) –Lucofin® 7440HFFR. With these grades LUCOBIT offers technical solutions where standard HFFR grades fail.

The unique structure of the ethylene butyl acrylate (EBA) moiety –as shown in figure 1- is resulting in a variety of technical advantages of EBA/ATH or EBA/MDH compounds as compared to compounds based on other ethylene esters, especially ethylene vinyl acetate.

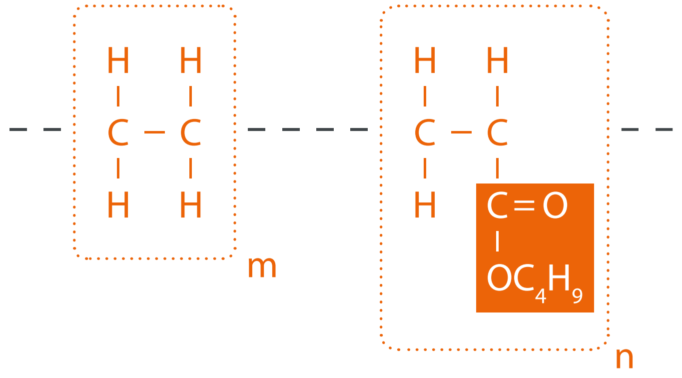


Figure 1: Molecular structure of ethylene butyl acrylate (EBA)

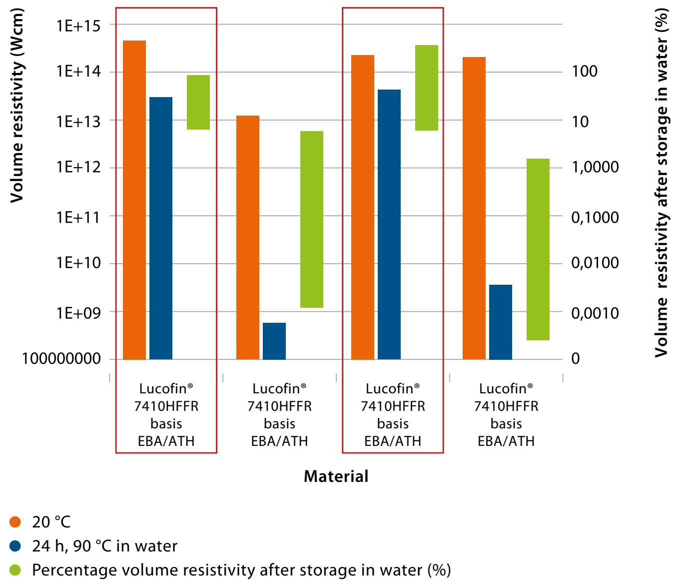


Figure 3: Volume resistivity of some HFFR grades and percentage volume resistivity before/after storage in water

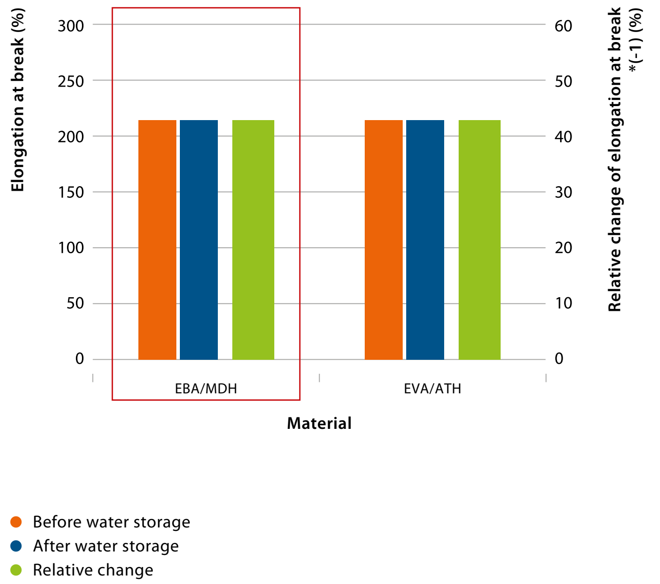


Figure 4: Elongation at break of some HFFR compounds before/after water storage and relative change

AGEING PROPERTIES

The thermal properties during end usage of EBA are better than the corresponding properties of EVA. Figure 7 shows, that the vicat softening and the melting point are higher for EBA with 16 % butyl acrylate as compared to EVA with a comparable vinyl acetate content.

Hence, the drop of elongation at break with increasing storage temperature is much less severe for an EBA based HFFR compound in comparison with an EVA based HFFR compound (see figure 8).

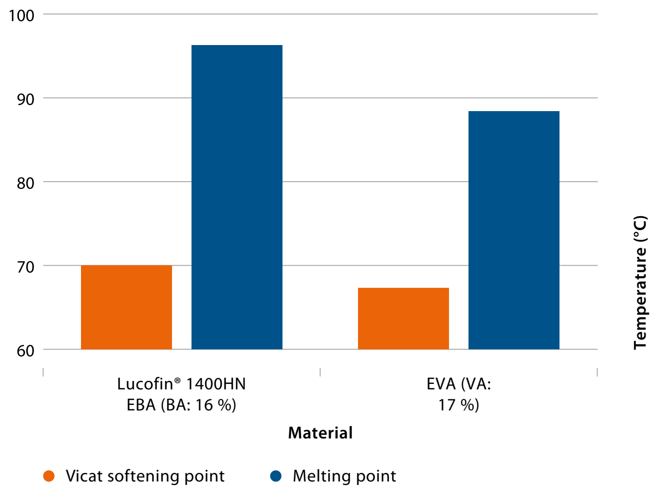


Figure 7: Vicat temperature and melting point of EBA and EVA of comparable comonomer content

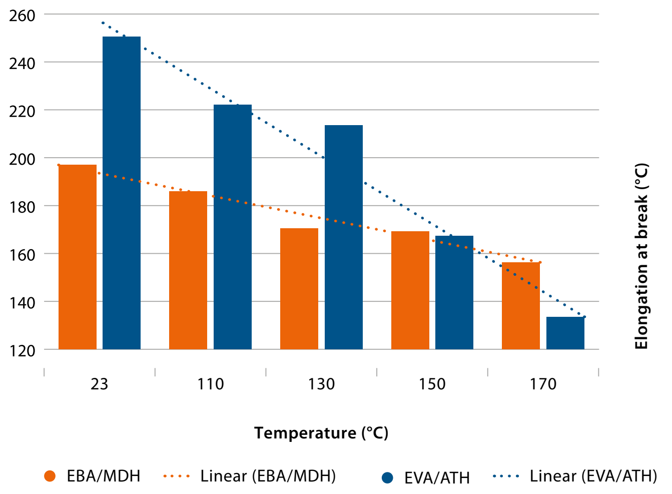


Figure 8: Elongation at break of HFFR compounds based on EBA/MDH and EVA/ATH as a function of storage temperature

WATER ABSORPTION AS WELL AS ELECTRICAL AND MECHANICAL PROPERTIES BEFORE/AFTER WATER STORAGE

Lucofin® 7410HFFR and Lucofin® 7440HFFR have a very low water absorption in the range of 0,5 mg/cm², whereas standard HFFR grades based on EVA have a water absorption well above 1,5 mg/cm² as shown in figure 2.

Consequently, the electrical properties, such as volume resistivity –as shown in figure 3- and mechanical properties, such as elongation at break –as shown in figure 4- of Lucofin® 7410HFFR and Lucofin® 7440HFFR exhibit a much less drop in these properties after water storage as compared to EVA based compounds. This is important for all cables –both jacketing and insulation- which are potentially exposed to moist conditions, such as buried cables, cables on ships and outdoor cables.

Ever since there is a pending demand from cable associations to set the maximum value of water absorption at 1 mg/cm², cable manufacturers are increasing looking for compounds which allow to pass this tough requirement. Lucofin® 7410HFFR and Lucofin® 7440HFFR do fulfill this requirement.

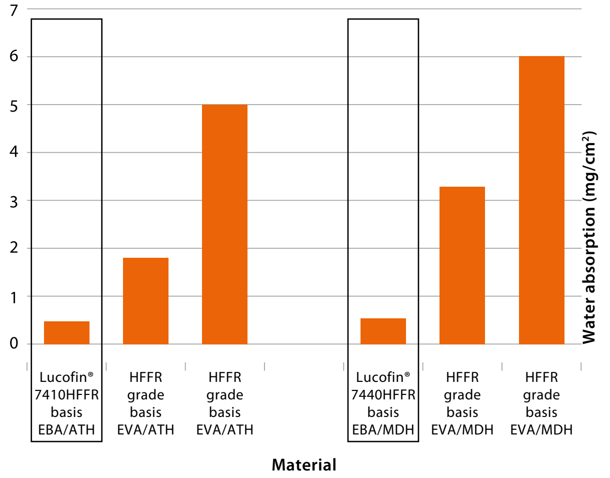


Figure 2: Water absorption of various HFFR grades

LOW TEMPERATURES PROPERTIES

Butyl acrylate has one of the lowest glass transition temperatures (Tg) of any polar ethylene copolymer. The Tg of butyl acrylate at -56 °C is far below the Tg of vinyl acetate at +28 °C. (figure 5). Therefore, EBA based HFFR compounds -Lucofin® 7410HFFR and Lucofin® 7440HFFR- maintain their flexibility at lower temperatures as compared to EVA based HFFR compounds (see Dynamical Mechanical analysis in figure 6). This is crucial for all cables in cold areas –either during usage or during installation-, especially in regions with harsh winters or for refrigerated rooms.

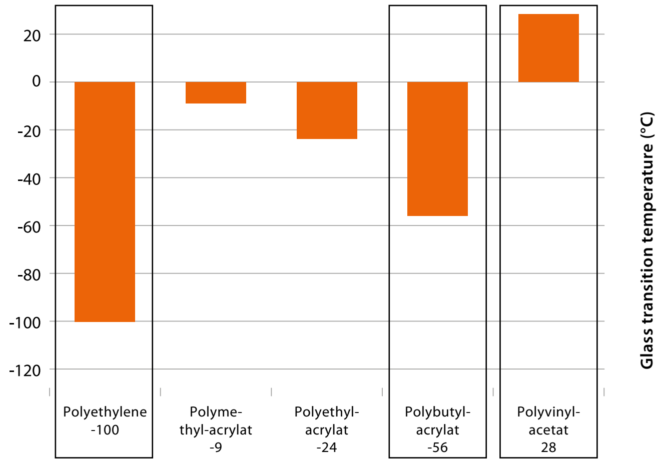


Figure 5: Glass transition temperature of polyethylene and some polar ethylene copolymers

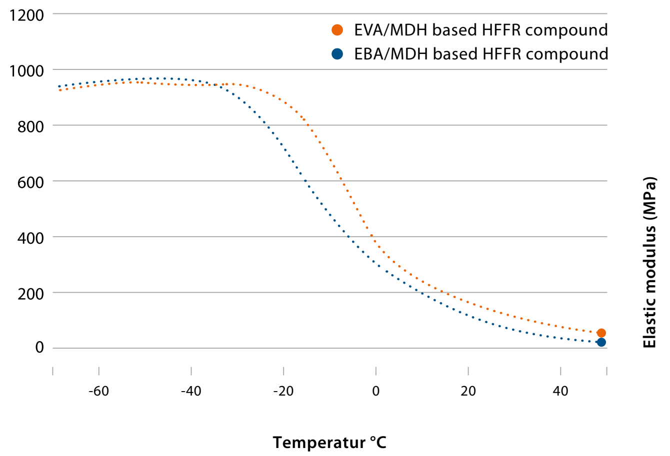


Figure 6: Dynamical Mechanical analysis (DMA) of HFFR compounds based on EVA/MDH and EBA/MDH

PRODUCTION OUTPUT

EVA cannot be processed at temperatures higher than 210 °C due to a thermal decomposition process yielding corrosive acetic acid which not only may harm the processing equipment but also the final cable. Opposed to that, EBA is stable to be processed up to 280 °C (figure 9). MDH thermally decomposes at temperatures >300 °C, ATH at around 180 °C.

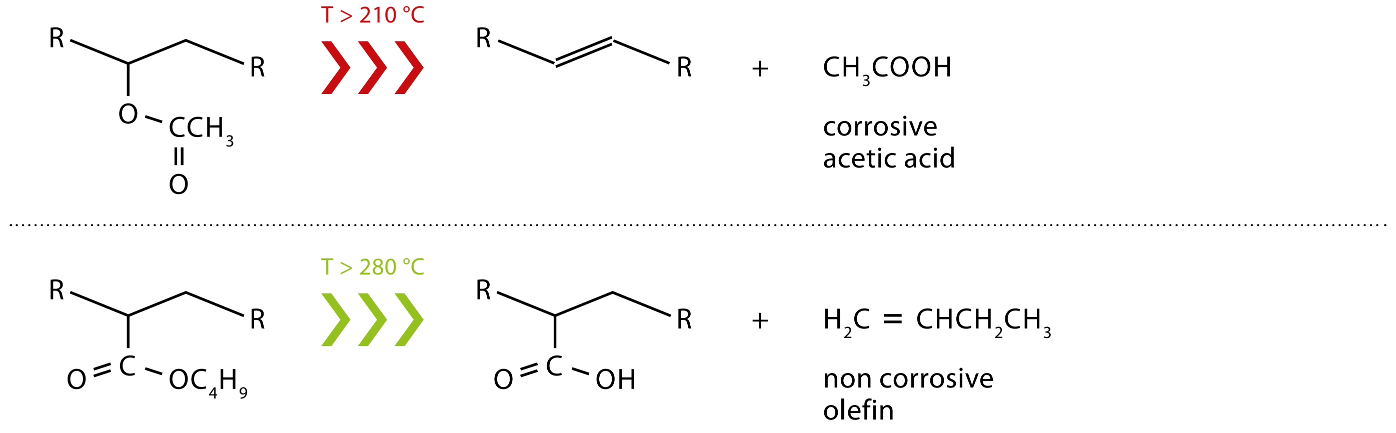


Figure 9: Thermal decomposition of EVA and EBA at different temperatures yielding corrosive and non-corrosive by-products, respectively