SYNTHESIS AND INVESTIGATION OF A HYBRID PVDF/FE-MOF BASED NANOCOMPOSITE

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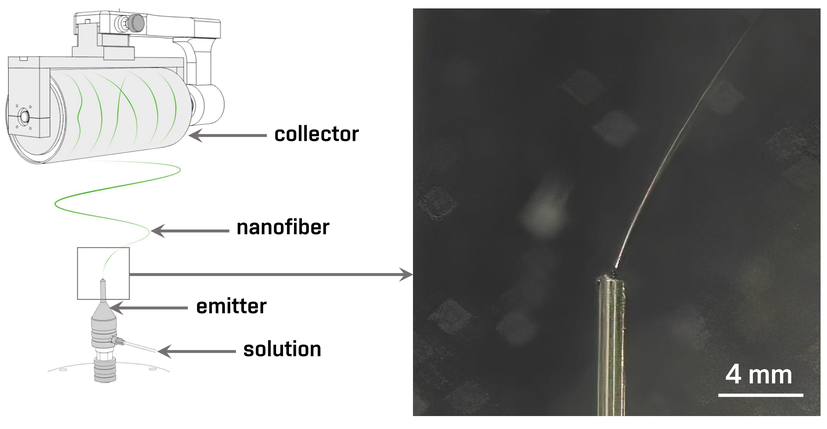
Abstract

This work focuses on the unexplored synthesis and material analysis of the composite based on nanofibers of the thermoplastic polymer called polyvinylidene fluoride (PVDF) and iron-based metal-organic framework (MOF) nanoparticles. In addition to high durability, PVDF has piezoelectric properties. When synthesized as nanofibers, it also provides a broader range of applications. MOFs can be used in the fields of hydrogen storage, catalysis, gas separation, or in multiferroics and ferroelectrics for supercapacitor applications. The proposed fibrous mat was designed and compared in several combinations, and the properties of the material were investigated using various advanced analytical methods. The incorporated iron-based MOFs significantly affect the physical properties of the fibers and their different phase conformations. Thus, the investigation of the fabricated nanocomposite with these two emerging components is the first step toward the development and application of novel PVDF/Fe-MOF functional materials.

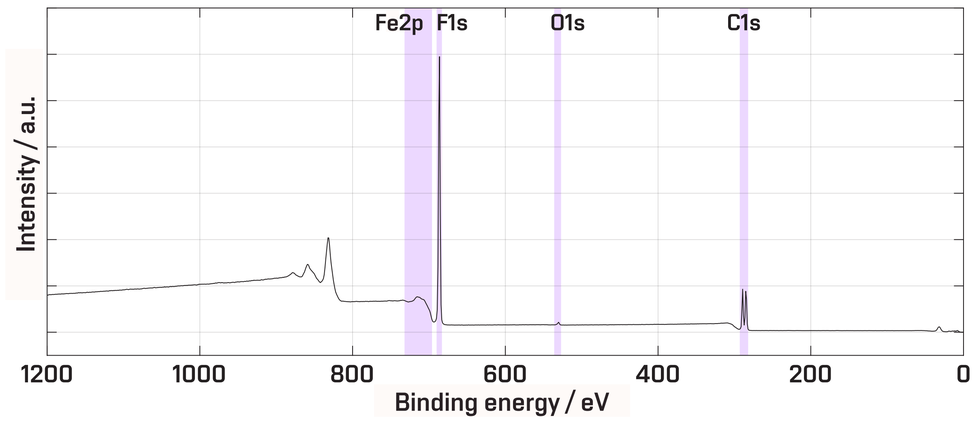
Fabrication

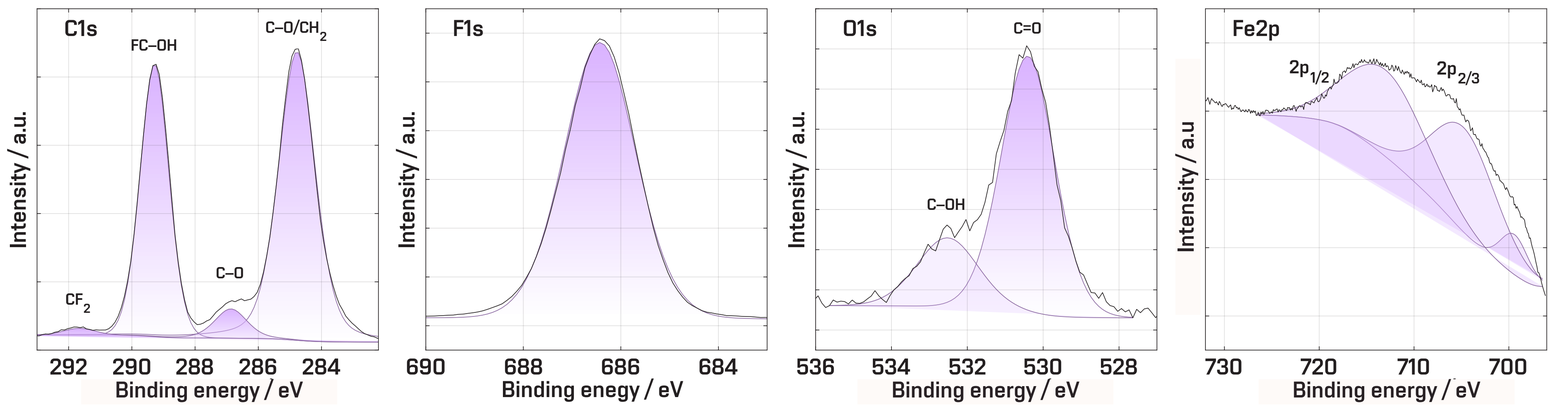


The nanofibers were synthesized using electrospinning with a single needle (emitter) and a rotating cylinder (collector). The solution was pumped from the syringe into the needle. So-called Taylor's cone was formed, and the fiber was attracted by electrostatic forces. During the flight to the collector, the solvent evaporated from the filament and the fiber was slowly wound on the cylinder.

X-ray Photoelectron Spectroscopy

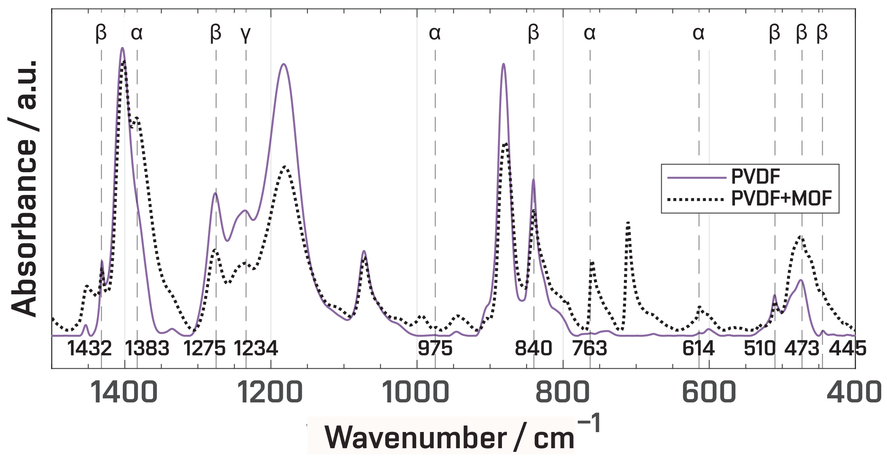
The survey spectra summarises the four most important high-resolution spectra. Bands of C1s, O1s, F1s, and Fe2p was investigated from PVDF/Fe-MOF sample. Pure PVDF is formed from $-(C_2H_2F_2)n-$. Last Fe2p belongs mainly to Fe-MOF. The sample is designed with 20 %wt PVDF and 5 %wt MOF.



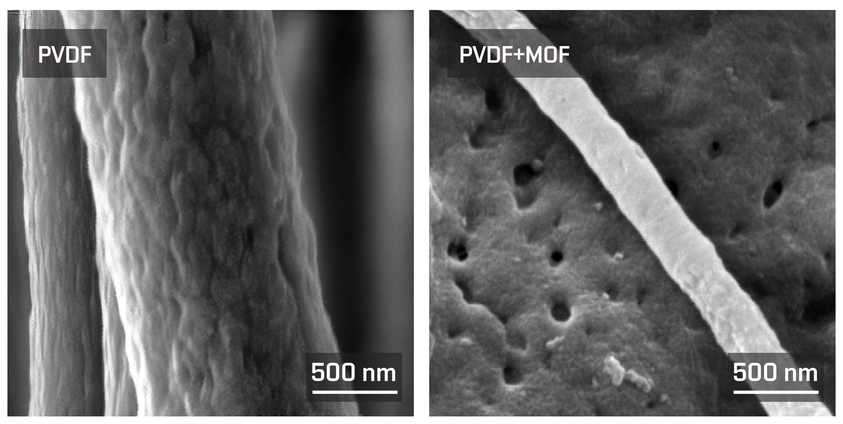


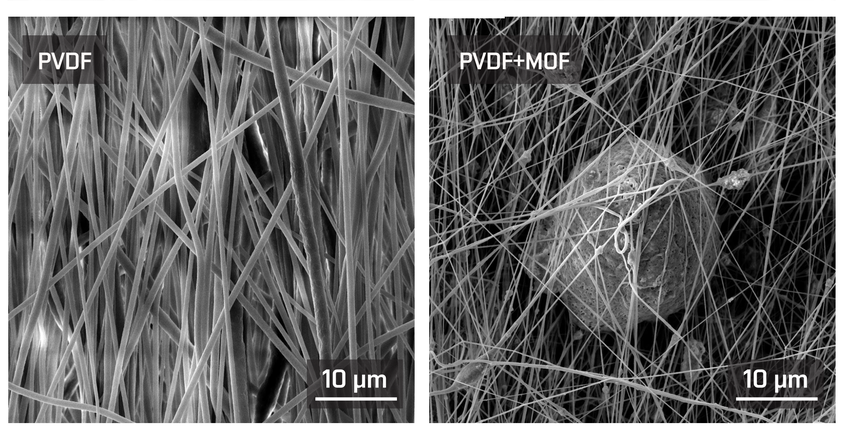
Fourier-Transform Infrared Spectroscopy

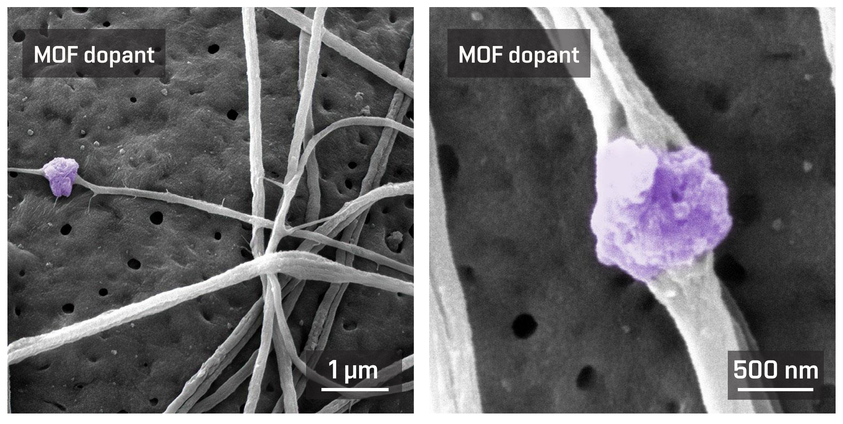
FTIR describes the distribution of the most important types of phases in the sample of pure PVDF and PVDF/Fe-MOF, that directly affect its electrical properties.



Scanning Electron Microscopy

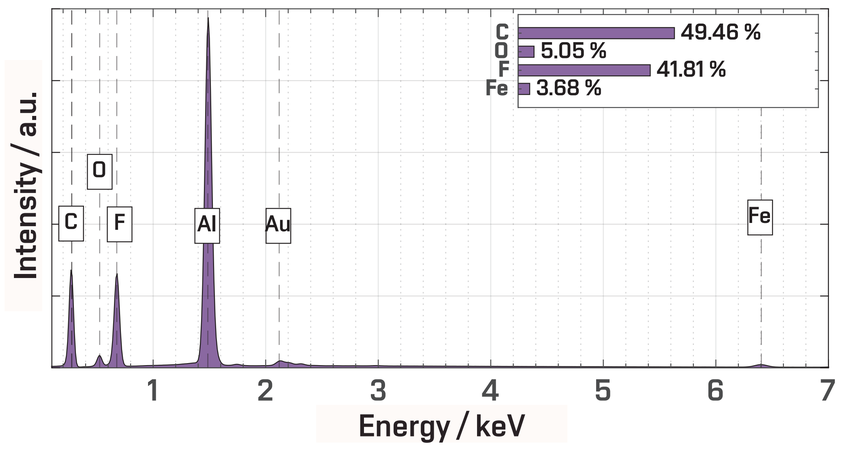






Energy-Dispersive Spectroscopy

EDS spectrum shows a slight presence of iron. A sample with 5 wt% MOF nanoparticles was used. However, when the concentration was increased to 8 wt%, the iron ratio increased minimally.



Conclusion

Findings confirmed that MOF was successfully trapped in the fibers, but also caused some side effects. One of these was the formation of a spherical structures that prevented the perfect arrangement and shape of the fibers. Compared to conventional pure PVDF fibers, the PVDF/Fe-MOF fibers achieved very small diameters. Spectroscopic measurements showed that PVDF/Fe-MOF exhibit a significantly higher α-phase than conventional fibers.