HIGH DENSITY POLYETHYLENE-BASED MICROPOROUS CARBON FIBERS AS HIGH-PERFORMANCE CATHODE MATERIALS FOR LI S BATTERIES

Tran N. H. A.[1], Richter M.[1], Hund R.-D.[1], Cherif C.[1], Wolz D.[2], Richter B.[2], Jäger H.[2], Härtel P.[3], Bönke T.[3], Kaskel S.[3]

[1] *Institute for Textile Machinery and High Performance Material Technology, TU Dresden, Dresden, Germany*
[2] *Institute of Lightweight Engineering and Polymer Technology, TU Dresden, Dresden, Germany*
[3] *Chair of Inorganic Chemistry, TU Dresden, Dresden, Germany*
nguyen_hoai_an.tran@tu-dresden.de

ABSTRACT

The fabrication of polyethylene-based carbon fibers has been known since late 1970's and the first patent was issued to Horikiri et al. in 1978. However, this fabrication process has not been further developed into an industrial process due to complexity of chemical stabilization (sulfonation) and carbonization process. Furthermore, the obtained polyethylene-based carbon fibers possess low tensile strength. Recently, we have successfully developed a new method for the fabrication of high density polyethylene (HDPE)-based carbon fibers using electron radiation treatment and following by carbonization. These developed HDPE-based carbon fibers have similar mechanical properties with the state of the art polyethylene-based carbon fibers but contain a special three dimensional interconnected microporous structure. Thus, the obtained microporous HDPE-based carbon fibers could be promising candidates as high-performance cathode materials for lithium-sulfur (Li-S) batteries.

The new deveoped HDPE GX5052 (, Mn=10.000 and Mw=70.000 g/mol) was kindly donated by LyondellBasell, Netherlands. Melt spinning experiments were carried out on a semi-industrial scale bicomponent melt spinning machine at the Institute of Textile Machinery and High Performance Material Technology (ITM). A spinneret having 72 holes was used. The diameter of each capillary hole of the spinneret was 0.3 mm with an aspect ratio L/D of 2. The take-up velocities were 2500, 3000 and 3500 m/min with the constant flow rate of 54 g/min.

The melt spun fibers were stabilized with electron beam radiation using a self-developed electron induced reactive processing (EIReP) at a room temperature at the Leibniz Institute of Polymer Research Dresden (IPF Dresden). The stabilizied HDPE fibers were then carbonized and graphitised up to 3000 °C using the carbonisation plant at IPF Dresden.

It was found that the HDPE-based carbon fibers posses a relative low tenaciy of 2000 Mpa in comparison to PAN-basierte carbon fibers. However, these HDPE-basierte carbon fibers have a special three dimensional interconnected microporous structure, which are very promising candiates as cathodes for lithium-sulfur (Li-S) batteries. The application of these innovative developed HDPE-based microporous carbon fibers for Li-S batteries is under investigation.

This study is a part of an interdisciplinary work that has been investigated by young scientists in the junior research group "e-Carbon" at the Dresden University of Technology (TU Dresden) and it is being supported by the Sächsische Aufbaubank SAB-ESF-100310387.