Material Science & Engineering | Technology Offer

Novel Carbonization Process of PAN-Nanofiber Mats with Enhanced Surface Area and Porosity

Field of application

This innovative carbonization process of carbon precursor fibers creates in a fast and energy saving manner carbon fibers (CF) which are highly porous (small pore diameters) and have a high surface area.
Filler materials like pigments, dyes, graphene nano-platelets or metal- and semiconductor nanoparticles can be admixed to vary the performance of the produced carbon fibers, e.g. to increase electrical conductivity. Applications of carbon fibers are known in the art. However, electric applications like super caps and electrodes or filtration and adsorption for gas, water and solvent purification will be preferable.

State of the art

In general, the process to manufacture carbon fibers uses two steps. First, the stabilization step, which converts the precursor polymer into an infusible structure in an oxidizing atmosphere and second, the pyrolysis step (i.e. graphitization). The pyrolysis usually requires temperatures between 700 °C and 4000 °C to gain the desired graphitic structures. Although varying alternative procedures exist, all known thermal carbonization steps are time-consuming and use energy consuming large ovens. Therein the fibers are subject to thermal gradients, resulting in slow release of the gaseous carbonization byproducts, generating undesired and smooth carbon fiber surfaces. Furthermore, additional chemical activation steps to improve the surface area require large amounts of corrosive liquids.
In summary, the known manufacturing processes for carbon fibers of today suffer from inhomogeneous pyrolysis and require additional treatment steps or additional compounds/catalysts.

Innovation

Inventors at DWI, Aachen have developed a novel technology to manufacture carbon fibers of increased purity, which have in addition a high surface area and wherein a high porosity of the carbon fibers is already induced during carbonization and pyrolysis (i.e. graphitization). At the same time, neither an additional activation step nor additional compounds are needed.
The innovative process uses IR lasers (alternatively microwave or assisted plasma heating can be used) allowing for precise, homogenous transfer of energy into the fleece and causing very fast blowout of the gaseous carbonization byproducts. By using IR lasers, ovens become obsolete.
Overall, this technology combines conventional carbonization and activation treatments into one process and is more economical by saving time, costs and resources compared to already known thermal carbonization methods.

Your benefits at a glance

- ✓ Fast pyrolysis step within minutes or even seconds
- ✓ Energy saving
- ✓ Nanometer sized pore diameters from 0.1 to 10 nm
- ✓ High surface area from 100 to 2500 m^2/g
- ✓ Increased purity, i.e. carbon content
- ✓ No additional additives like pore-providing templates, catalytic compounds or corrosive liquids needed
- ✓ Filler materials like metal- and semiconductor nanoparticles or graphene nanoplatelets can be mixed in to vary the performance of the carbon fibers
- ✓ Process uses PAN, pitch, cellulose or lignin derived precursor material

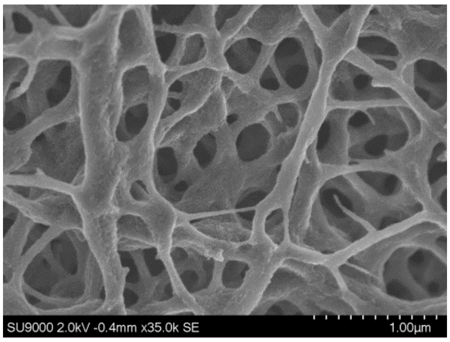

Figure 1: Micrograph of a highly porous carbon fiber fleece.

Technology transfer

Technologie-Lizenz-Büro GmbH is responsible for the exploitation of this technology and assists companies in obtaining licenses.

Patent portfolio

European patent application pending.

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