

Preparation of inorganic materials via electrospinning – a basic approach for novel materials

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The electrospinning [1] is a well-known laboratory method for producing fibers in a range of tens of nanometers up to several micrometers thickness. Since the beginning of the 21st-century extensive research has been done in the field of nanofiber research. Many applicable nanofibrous materials have been synthesized, described, and also industrially produced. Next to the broad family of organic polymeric ultrathin fibers, various inorganic materials have been produced. However, many exploitable and relatively basic compounds have not been produced in nanofibrous form yet. The goal of the lecture is to present research techniques and major results of the preparation of novel nanofibrous materials.

Uranium dioxide [2] is the most important form of uranium in nuclear industry today due to its usage in the nuclear fuel pellets. Nanoscopic fuel forms, especially nanoparticles, are highly desired materials in accident-tolerant fuel forms. We have enlarged the family of nanoscopic uranium-based materials with the preparation of nanofibrous U₃O₈ and UO₂. Produced polycrystalline UO₂ nanofibers have thickness of 91 ± 89 nm.

A similar situation as in the case of uranium oxides has been observed in the case of thorium dioxide which has not been prepared in nanofibrous form. We have studied [3] two preparation routes, the aqueous and organic solvent-based methods. Prepared polycrystalline nanofibers were in the range of tens of nanometers in average diameter. The biggest surface area achieved in this work was 52 m² g⁻¹. ThO₂ has potential in heterogeneous catalysis, refractory materials, and the nuclear power industry.

Despite the fact, that tungsten metal is highly wanted material and its nanoscopic forms (nanoparticles, single-crystalline nanowires) are well described [4], the preparation of polycrystalline tungsten nanofibers has been performed only via low-scale methods. For the first time, we are describing the multigram preparation of silica-doped tungsten nanofibers prepared by needle-less electrospinning.

Tungsten disulfide is a deeply studied material with a broad application field [5]. We used an aqueous solution of silicotungstic acid (H₄SiW₁₂O₄₀) and polyvinyl alcohol (PVA) as precursors for the synthesis of composite fibers by the needle-less electrospinning technique. The obtained green fibers (av. diam. 460 nm) were converted by calcination in air to tungsten oxide WO₃ fibers with traces of SiO₂ and a smaller diameter (335 nm). The heat treatment of the WO₃ fibers under flowing H₂/H₂S/N₂ stream led to conversion to tungsten sulfide WS₂ with retention of fibrous morphology (av. diam. 460 nm).

References:

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