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BOOK OF ABSTRACTS

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TABLE OF CONTENTS

XVII International Sol-Gel Conference

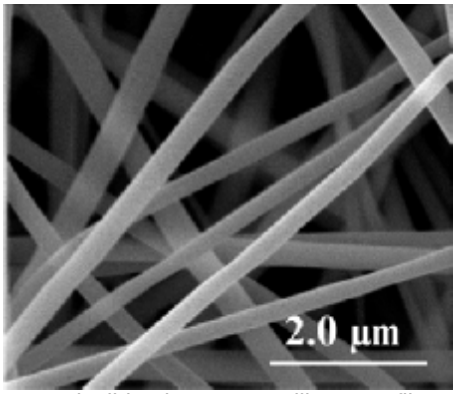
POSTERS

P-A-3

Stable electrospinning of silica nanofibres: influence of viscosity

Jozefien Geltmeyer[(1)], Lien Van Der Schueren[(1)], Klaartje De Buysser[(2)], Karen De Clerck[(1)]
1.- Fibre And Colouration Technology Research Group, Department Of Textiles, Faculty Of Engineering And Architecture, Ghent University
2.- Sol Gel Centre For Research On Inorganic Powder And Thinfilm Synthesis, Department Of Inorganic And Physical Chemistry, Faculty Of Sciences, Ghent University

Electrospinning is an efficient technique using electrostatic forces to obtain nanofibres. Combining with the sol-gel process, electrospinning showed to be suitable for the preparation of ceramic nanofibres. Because of the small diameter of nanofibres, nanofibrous structures show unique properties such as small pore sizes, high porosity and high specific surface area. Electrospinning of polymer nanofibres has been studied extensively. As a consequence, electrospinning of polymer nanofibres is possible via stable, reproducible and controllable processes. Studies on ceramic nanofibres are less comprehensive. However, their high temperature resistance and chemical inertness allow ceramic nanofibres to be used for various applications such as biomedical applications, filtration, composites, catalysis, etc. Ceramic nanofibres can be obtained via two possible routes, namely by electrospinning of pure alkoxide precursors or by electrospinning of alkoxide precursors with carrying polymer. The latter is most often applied to facilitate electrospinning but due to the thermal treatment, necessary to remove the carrying polymer, the surface becomes rough and uneven resulting in poor mechanical properties. Although being more challenging, electrospinning of pure alkoxide precursors is thus preferred. So far, no attention has been given to the stability of the electrospinning process, which is, however, an essential prerequisite to allow for a potential up-scaling of the system.
Therefore a detailed study on the electrospinning of silica nanofibres is vital. In this study the focus is on the electrospinning of tetraethyl orthosilicate (TEOS), the most widely used silica precursor. The sol characteristic mainly affecting the electrospinning process is believed to be the viscosity. The viscosity range allowing for uniform and reproducible nanofibres is determined, followed by an analysis of the fibre morphology. Next, the influence of the preparation procedure of the sol electrospinning solutions on the resulting nanofibres is established. Sols were prepared by heating a mixture of TEOS, ethanol, distilled water and hydrochloric acid until a desired viscosity was obtained. It was found that nanofibres could be produced with sols having viscosities between 100 and 1000 mPa.s. However, stable and reproducible electrospinning resulting in uniform and beadless nanofibres was only possible in a much narrower viscosity window. The optimal viscosity window resulted in the lowest mean nanofibre diameter, having diameters in between 250 nm and 300 nm. A sol with a too high viscosity to allow for stable elctrospinning could be further processed into nanofibres after dilution. However, electrospinning was less stable for those diluted sols. Electrospinning with a freshly prepared sol is thus the best way to obtain uniform nanofibres in a stable, reproducible manner. This study showed that stable electrospinning of silica nanofibres is possible in an optimum viscosity range of the sol, resulting in uniform, reproducible nanofibres.



Reproducible electrospun silica nanofibres