World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:9, No:11, 2015

Self-Healing Coatings and Electrospun Fibers

Authors : M. Grandcolas, N. Rival, H. Bu, S. Jahren, R. Schmid, H. Johnsen

Abstract : The concept of an autonomic self-healing material, where initiation of repair is integrated to the material, is now being considered for engineering applications and is a hot topic in the literature. Among several concepts/techniques, two are most interesting: i) Capsules: Integration of microcapsules in or at the surface of coatings or fibre-like structures has recently gained much attention. Upon damage-induced cracking, the microcapsules are broken by the propagating crack fronts resulting in a release of an active chemical (healing agent) by capillary action, subsequently repairing and avoiding further crack growth. ii) Self-healing polymers: Interestingly, the introduction of dynamic covalent bonds into polymer networks has also recently been used as a powerful approach towards the design of various intrinsically self-healing polymer systems. The idea behind this is to reconnect the chemical crosslinks which are broken when a material fractures, restoring the integrity of the material and thereby prolonging its lifetime. We propose here to integrate both self-healing concepts (capsules, self-healing polymers) in electrospun fibres and coatings. Different capsule preparation approaches have been investigated in SINTEF. The most advanced method to produce capsules is based on emulsification to create a water-in-oil emulsion before polymerisation. The healing agent is a polyurethane-based dispersion that was encapsulated in shell materials consisting of urea-benzaldehyde resins. Results showed the successful preparation of microcapsules and release of the agent when capsules break. Since capsules are produced in water-in-oil systems we mainly investigated organic solvent based coatings while a major challenge resides in the incorporation of capsules into water-based coatings. We also focused on developing more robust microcapsules to prevent premature rupture of the capsules. The capsules have been characterized in terms of size, and encapsulation and release might be visualized by incorporating fluorescent dyes and examine the capsules by microscopy techniques. Alternatively, electrospinning is an innovative technique that has attracted enormous attention due to unique properties of the produced nano-to-micro fibers, ease of fabrication and functionalization, and versatility in controlling parameters. Especially roll-to-roll electrospinning is a unique method which has been used in industry to produce nanofibers continuously. Electrospun nanofibers can usually reach a diameter down to 100 nm, depending on the polymer used, which is of interest for the concept with self-healing polymer systems. In this work, we proved the feasibility of fabrication of POSS-based (POSS: polyhedral oligomeric silsesquioxanes, tradename FunzioNano™) nanofibers via electrospinning. Two different formulations based on aqueous or organic solvents have shown nanofibres with a diameter between 200 – 450nm with low defects. The addition of FunzioNano™ in the polymer blend also showed enhanced properties in term of wettability, promising for e.g. membrane technology. The self-healing polymer systems developed are here POSS-based materials synthesized to develop dynamic soft brushes.

Keywords : capsules, coatings, electrospinning, fibers
Conference Title : ICNSE 2015 : International Conference on Nanomaterials Science and Engineering
Conference Location : Venice, Italy
Conference Dates : November 09-10, 2015

Open Science Index, Chemical and Materials Engineering Vol:9, No:11, 2015 publications.waset.org/abstracts/32221.pdf