Avinash Baji et al., J Material Sci Eng 2017, 6:2 (Suppl)
http://dx.doi.org/10.4172/2169-0022.C1.061

Fabrication of hierarchical structures using electrospinning for dry adhesive applications

Avinash Baji and **Rahul Sahay**
Singapore University of Technology and Design, Singapore

In this study, hierarchical structures for dry-adhesive applications were fabricated using electrospinning combined with template wetting method. Briefly, in the first step, electrospinning technique was used to produce micron sized fibers which were directly deposited on porous anodized aluminum oxide (AAO) template. Following this step, the setup consisting of the AAO template along with the fibers was heated above the glass transition temperature of polymer. This enabled the flow of polymer within the porous channels and resulted in the growth of nanometer sized pillars on the surface of the fibers. Based on this fabrication technique, we produced hierarchical structures using two different polymeric systems, viz. poly(methyl methacrylate) (PMMA) and poly(vinylidene fluoride) (PVDF). A representative scanning electron microscopy (SEM) image of the fibers is shown in Figure-1. The SEM image shows that this approach led to the growth of sub-nano structures on the surface of the fibers. These samples were used to investigate the normal as well as shear adhesion behavior of hierarchical structures. The normal adhesion was characterized using a nanoindenter. A flat circular indenter tip (diameter=10 μm) was used to indent the surface of the samples and then retracted back. The pull-off required to separate the indenter tip from the samples was recorded. This pull-off force gave an indication of its normal adhesion. Similarly, the samples were finger pressed onto sandpaper with varying degree of roughness. The samples were then pulled in shear and the shear adhesion force was characterized. Fibers without any surface structures were also tested and their adhesion behavior was compared with that of hierarchical samples. The samples with surface nanostructures exhibited increased pull-off force compared to neat control samples due to its improved van der Waals interactions.

Biography

Avinash Baji focuses on bio-inspired materials research using electrospun polymer fibers. His current research interests include fabrication of electrospun fibers for dry adhesion applications. He aims to mimic the geometry and adhesive mechanisms of natural materials using electrospinning enabled techniques. He has authored over 35 journal articles with additional papers in conference proceedings.

avinash_baji@sutd.edu.sg

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