

2008 American Filtration Society Annual Conference
May 19-22
Valley Forge PA

Nanoscale probing of charge degradation in polypropylene electret fibers via electrostatic force microscopy

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Abstract

Electrostatic Force Microscopy (EFM) was used to directly probe charge degradation at the nanoscale in electret filter media in individual fibers. Electrostatic force gradient images of individual polypropylene fibers were used to quantify the extent of charge degradation caused by the immersion of the fibers in to isopropanol. Electrostatic force gradient images were obtained by monitoring the shifts in phase and frequency between the oscillations of a biased AFM cantilever and those of the piezoelectric drivers. EFM measurements were performed using non-contact scans at a constant tip-sample separation of 75 nanometers with varied bias voltages applied to the cantilever. Mathematical expressions, based on the capacitance of the tip-sample system, were used to model the phase and frequency shifts as functions of the applied bias voltage to the tip and the offset voltage due to the fiber's charge. Quantitative agreement between the experimental data and the simplified model was observed. This work is of great relevance to filtration design and manufacturing as it unveils a new tool to probe electrostatic charges in fibers with nanoscale resolution.

