Conductive nanocarbon composite films made by dielectrophoretic alignment

G. Helgesen*
Physics Department, Institute for Energy Technology (IFE)
PO Box 40, NO-2027 Kjeller, Norway

M. Knaapila
Department of Physics, Technical University of Denmark (DTU)
Fysikvej 307, DK-2800 Kgs. Lyngby, Denmark

Conductive, low volume-fraction nanocarbon composite films can be made by dielectrophoretic alignment of nanoparticles using alternating electric fields. [1] In these materials the particle fraction can be well below the isotropic percolation threshold, and the resulting films will be nearly transparent. The conductive nanoparticles can be carbon nanotubes, carbon cones [2] and disks, multilayer graphene or carbon black. After mixing the particles into the polymer and spreading this mixture into a thin film, the particles are aligned by the electric field from pairs of electrodes placed just below the film or on each side of the film. Thus, the direction of high electric conductivity can be either parallel or perpendicular to the layer. [3,4] The particle chains get fixated in the film after curing by heat or UV-light. Films that are prepared from an elastomer matrix show piezoresistivity and can therefore be used as micromechanical strain or pressure sensors. [5,6]

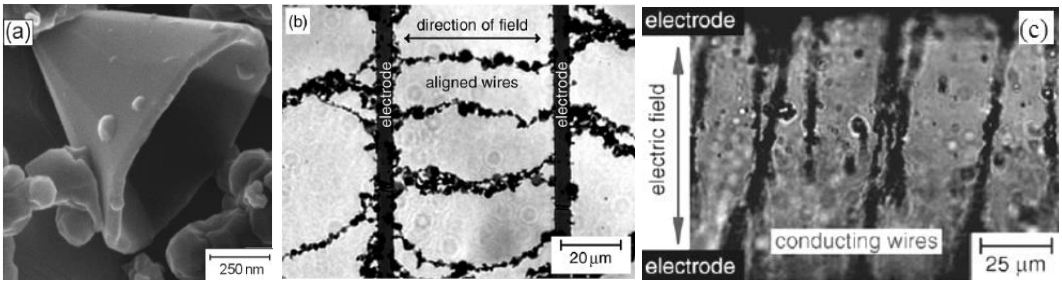

Figure 1: a) Carbon cone, b) carbon particles aligned using electrodes below the film, and c) particles aligned using electrodes below and above the film (side view).

References

[1] M. Knaapila, H. Høyer, and G. Helgesen, Eur. Phys. J. Special Topics **223**, 1869 (2014).
[2] S.N. Naess, A. Elgsaeter, G. Helgesen, and K.D. Knudsen, Sci. Technol. Adv. Mater. **10**, 065002 (2009).
[3] M. Knaapila, O.T. Rømoen, E. Svåsand, J.P. Pinheiro, Ø.G. Martinsen, M. Buchanan, A.T. Skjeltorp, and G. Helgesen, ACS Appl. Mater. Interfaces **3**, 378 (2011).
[4] M. Knaapila, H. Høyer, E. Svåsand, M. Buchanan, A.T. Skjeltorp, and G. Helgesen, J. Polymer Sci. B: Polymer Physics **49**, 399 (2011).
[5] H. Høyer, M. Knaapila, J. Kjelstrup-Hansen, X. Liu, and G. Helgesen, Appl. Phys. Lett. **99**, 213106 (2011).
[6] M. U. Sandsaunet, M. Knaapila, L. Tavares, J. Kjelstrup-Hansen, and G. Helgesen, Polymer Composites **36**, 1866 (2015).

* geir.helgesen@ife.no