Self-assembly of carbon nanotubes for thin conductive films

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Carbon nanotubes (CNTs) are promising materials to develop novel conductive inks potentially useful in organic electronics for flexible circuitry or transparent electrodes. Indeed, carbon nanotubes exhibit a high aspect ratio, an excellent chemical stability and a high electrical conductivity. Because of their large aspect ratio they can form conductive networks at low concentration. The optical and electrical properties of thin films depend on the intrinsic properties of CNTs but also on their structuration on a given substrate. This structuration is imposed by the processing used to deposit CNTs from a fluid phase and on the interactions between the nanotubes.
We will discuss in this presentation some aspects related to the self-assembly of CNTs for the development of thin conductive films. A key objective for transparent electrodes is the control of the network morphology to combine high conductivity and optical transmittance. We will discuss in particular the influence of interactions between the CNTs. The latter affect the rheological, wetting and self-assembly properties of CNT dispersions. It is theoretically expected that weak attractive forces should promote local alignment of the CNTs along with a decrease of the percolation threshold [1, 2]. Local alignment should lead to better electrical contacts. We have recently validated these theoretical expectations. Cryo-TEM analyses show that increasing the surfactant concentration in the dispersion actually promotes contacts and local alignment of CNTs. Weak attractive interactions result in an increase of the ink viscosity which yields improvements of processability. For other applications, such as flexible circuitry, aligned and packed CNTs are preferable. CNT because of their aspect ratio can form liquid crystals which are well suited to form self-assembled anisotropic conductors. We will present recent results on the relationship between the order parameter of CNT liquid crystals and the electrical properties of CNT thin films [3].

References

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