Nanofibres by electro-spinning of polymer solution

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A very thin liquid jets can be obtained using electric fields. The electrically-driven bending instability of the jet enormously increases the jet elongation path and effectively leads to its tinning by very large ratios. The process, known since several years [1-3] as electrospinning, offers simple and cost effective method of producing solidified polymer nanofibres.
Unfortunately, the jet instability responsible for the thinning process is still difficult to control. Under ordinary conditions it causes that collected fibres are randomly oriented, their diameter and structure may vary in a broad range. Also the efficiency of nanofibres production is difficult to increase. The aim of the present study is to obtain detailed experimental data on the process itself and to correlate these data with the existing models describing basic mechanisms responsible for the electrospinning.

The experimental setup consists of a pipette sustaining a pendant droplet, a high voltage DC source, a conducting mat for the nanofibres collection, and optical system for image acquisition. A bright field illumination using Fresnel lens is used in most cases. Three camera systems are used to collect transient parameters of the jet and measure details of the collected nanofibres: standard 25Hz video camera (768x564pixels), high-resolution PIV camera (1300x1024 pixels) and high speed imaging system Fastcam (256x256 pixels). As a working fluid a water-alcohol solution of polyethylene oxide is used. The main parameters varied during experiments are strength and uniformity of the electric field, solution concentration, working distance (length of the jet looping sector), and direction of the gravity field.

The high speed imaging system, as well as a double pulse laser with the PIV camera are used to evaluate local velocity of the jet during its tinning process. Details of geometry of the looping cone are recorded by the standard video camera. Structure of the product is analysed using microscopic system and the high-resolution camera. To estimate magnitude of the jet stretching forces, controlled air flow is used and its effect on the deformation of a segment of the jet analysed. The data collected are used to verify the analytical model given by Reneker et al. [2].

[1] Reneker D.H., Chun I.: Nanotechnology, **7,** 216 (1966)
[2] Reneker D.H., Yarin A.L., Fong H., Koombhongse S.: J. Appl. Physics **87**, 4531 (2000)
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