Nisco Engineering AG
Wehntalerstrasse 562
CH-8046 Zurich, Switzerland

Tel: +41 44 380 06 30
Fax: +41 44 380 06 31
e-mail: mailbox@nisco.ch
http://www.nisco.ch

Aerodynamically assisted jetting: a rapidly emerging microfabrication methodology

Nanosciences have become dominant in the scientific world. Several approaches for handling advanced materials in nanodomain have been developed. Ink-jet printing (IJP) is successfully used for a wide range of materials in the nanoscale >50nm but fail under 50nm. Two other techniques (electrosprays for forming droplets and electrospinning for forming a continuous thread) have also shown great promise but must be applied under hazardously high voltage. The new approach by means of aerodynamically assisted jets (AAJ) demonstrated in this paper is free of above mentioned problems.

This study investigated a range within ~0.01-5 bar and 4-10ml/h of applied pressure to flow rate. The aim of investigation was to identify the operating parameters that would allow the production of the finest possible droplets and droplet residues. By setting the minimum possible flow rate and increasing the applied pressure the jetting seized, which was caused by the compressed air flowing back into the syringe, a phenomenon called *back flow.* Therefore, the media flow rate was increased and a pressure was applied to avoid back flow. High-speed imaging showed that a jet was formed from which droplets were generated. The process was repeated several times in order to generate the operational guide. The silicone oil of 100mPas, 300mPas and 1000mPas was used. However, unlike the first two media, the silicon oil with viscosity 1000mPas had two distinct regions demarking threading and droplet generation (Fig. 1).

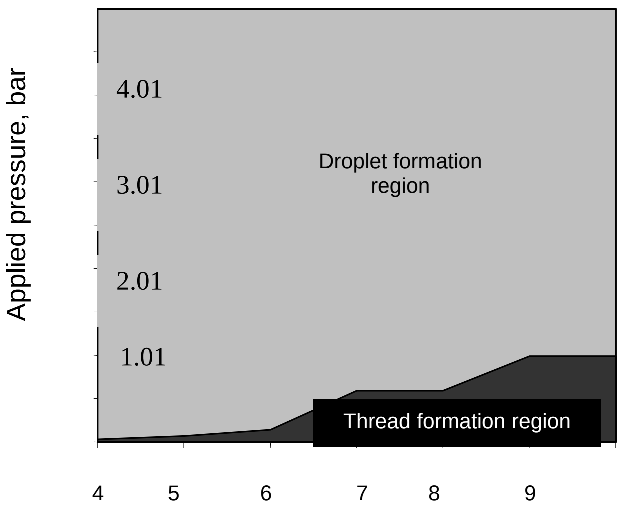

Fig. 1 Flow rate ml / hr

Researches believe this is promoted by the liquid viscosity together with the rheological properties, which assists in drawing out of the media via the exit orifice and subsequent thinning out to a uniform micrometre sized thread.

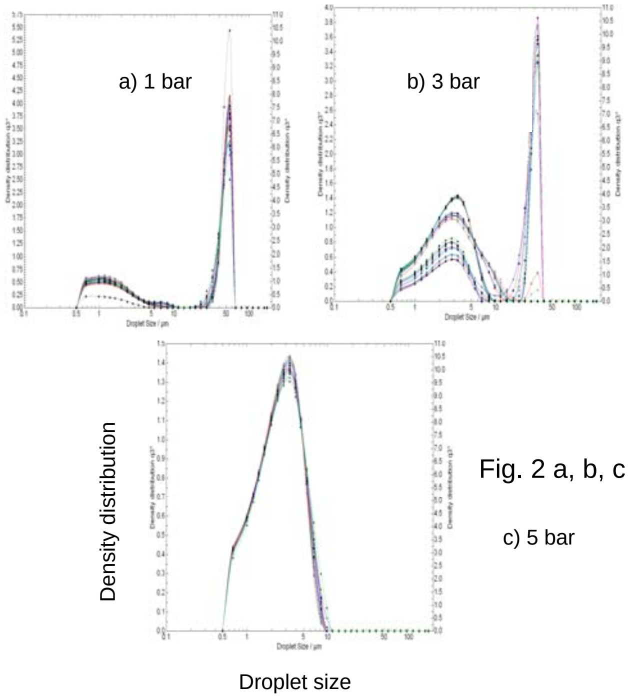

Fig. 2 a, b, c

Figure 2 shows characteristic repeated droplet size distributions for an applied flow rate of 10 ml/h for AAJ of the 100mPas silicon oil for an applied pressure: a -1bar, b -3 bar, c -5 bar. It was clearly seen that droplets were generated for all the media. On increasing the applied pressure to 3 bar, the droplets became finer (~40µm) and shifted the two peaks to the left-hand side. At 5 bar, the droplets still reduced in size and showed the generation of a mono-modal distribution of droplets of 0.5-13 µm (Fig. 2c). Using other viscosities also brought about a mono-modal distribution.

Generally, the investigation were carried out at very high applied pressure (never before done) and showed a near mono-distribution of droplets. The droplets were much finer then via ink-jets and formed dense self-assembled structures which are most useful in a wide range of materials science and engineering applications.

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