Versatile Methodology for Generating Size-Controlled Composite Micrometer Beads Capsulating Nanomaterials

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Aerodynamically assisted jetting as a new way of the precision deposition of droplet residues shows a great promise in material science and engineering. Competing successfully with its rivals such as ink-jet printing (operates only in the micrometer remit) and electrospraying (involves some hazards for the operator) this new processing approach is most useful in micro- and nanosciences. It allows encapsulating a wide variety of nano-sized materials as composite beads for applications in pharmaceutical industry.

A new jet processing rout – aerodynamically assisted jetting (AAJ):

- is capable to handle media at a wide range of both applied chamber pressure to flow rates.
- can generate droplets in the few micrometres to residues in the nanometres.
- produce beads which are stable over several months

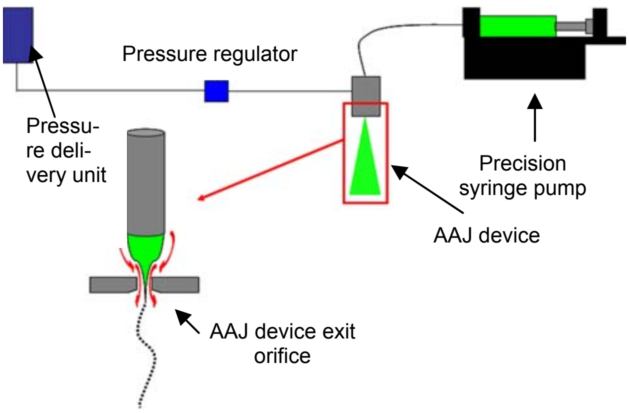

Fig. 1 Schematic representation of the AAJ device

The AAJ device (Fig.1) made by Nisco Engineering Inc. has an internal chamber height and diameter of ~16.2 and ~8.2 mm, respectively. A threaded needle that fits firmly in place with the internal threading on the chamber is gas tight and has an internal diameter of ~350µm. When fitted, the exit orifice is ~200µm below and in-line with the needle exit. The exit orifice has been countersunk externally and has a diameter of ~350µm. In addition to the threaded needle already fitted that holds the flow of media, there is a second input to the chamber accommodating the flow of compressed air, giving rise to the pressure difference over the exit orifice assisting in the formation of a jet. The needle holding the flow of media has a syringe connect to it by means of silicone tubing to a hypodermic needle. The syringe fits firmly on a syringe pump. The input of compressed air into the chamber is digitally regulated via a precision regulator. The alginic acid with low viscosity is used. The generated composite droplets are collected by the AAJ device exit orifice directed in-line with a bath having $CaCl_2$ solution. The bath is placed on a magnetic stirrer having a magnetic rotary arm in the bath.

During the experiments by keeping the applied pressure constant and varying the flow rate to the needle it has been seen that at the highest flow rate the droplets sized > 300µm have been generated, which have had a near-mono dispersity. On reducing the flow rate the smaller droplets have been generated. If the flow rate has been lowed even further, the jetting process has seized (Fig.2).

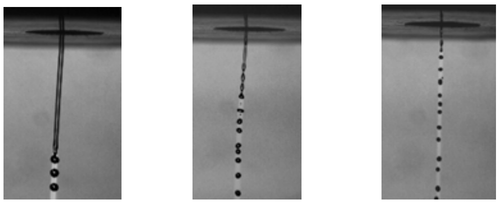

Fig. 2 Constant pressure and varying flow rate

By keeping the flow rate constant and varying the chamber pressure the jet has been able to form stable primary near one-sized composite droplets and beads. When the applied chamber pressure has been raised, the jet has been seen to whip (Fig.3).

Fig. 3 Constant flow rate and varying pressure

This flyer is based on the following publication:
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