P-032 **Design parameters on alginate beads produced with high electric potential i.e. electrodripping**

Poncelet D.*[1], Sayad M.[1], Davarci F.**[1], Ozcelik B.[2], Guessasma S. [3]**
[1] Oniris, Nantes, France, [2] Istanbul Technical University, Turkey, [3] INRA, Nantes, France
* Supervisor # denis.poncelet@bioencapsulation.net ** students who did the work

INTRODUCTION AND OBJECTIVES

Application of an electric potential on a droplet during its formation at the end of a tip or needle leads to reduction of size (Burgarski, 1999). This phenomenon is due to the repulsion of the charges at the surface of the droplet which reduce the droplet surface tension (Poncelet, 1999a). This may be expressed by :

$$m\ g = \pi\ d_e\ \gamma\ (1-\frac{U^2}{U_c^2}) \quad \text{and} \quad m = \frac{\pi}{6} d^3\ \rho$$

where m is the mass of the droplet, g the gravity force, de the diameter of the tip, γ the initial surface tension, U applied potential, U_c the critical potential (see below), d the diameter of the drop, ρ the density of drop. One may observe that when $U = U_c$, the second term becomes null. In such conditions, the liquid flowing from the tip will form a jet, which will break in small droplets.

The objective of this study was to optimize the design of the system to propose a more "friendly" set-up for the electrodripping system.

MATERIAL AND METHODS

Alginate solution (20 g/L, Algigel 3031, Degussa, France) was dropped in a 18 g/l $CaCl_2$ solution (Panreac, Spain) using a syringe pump and 30 ml syringe connected to tronconique tip (EFD, France). An electric potential (0 to 10 kV) was applied by an electrostatic generator (Bertan, series 205B Beads were let curing 15 min, filtered and observed under microscope to determine the size (Visilog software) and the critical potential.

Images of the droplet formation were recorded with a Phantom v7.3 camera (Vision Research, USA) at 400 images per second.

RESULTS AND DISCUSSION

Formation of the droplets was observed by video recording at two different voltages (Figure 1). For 0 kV, the droplet grows at the end of the tip. A Small neck is formed between the tip and its breakage releases the droplet. While a potential is applied (6 kV), a liquid cone is formed at the end of the tip with a long neck from where is released an elongated droplet. The resulting droplet is smaller (released every 100 ms against 650 ms without voltage and same flow rate).

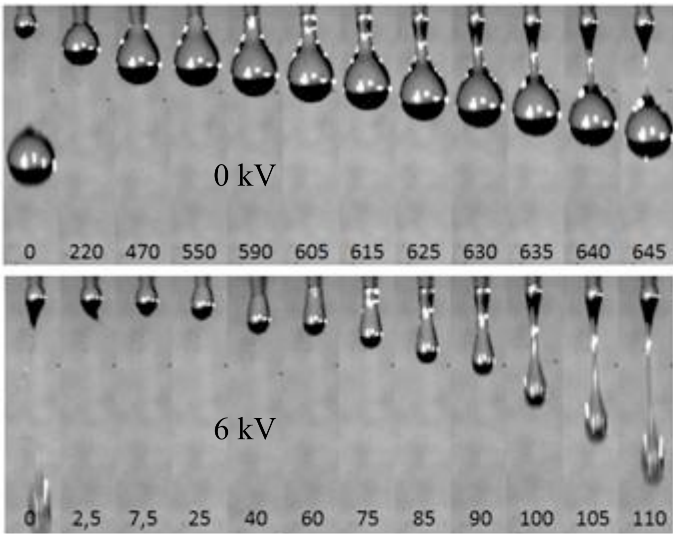
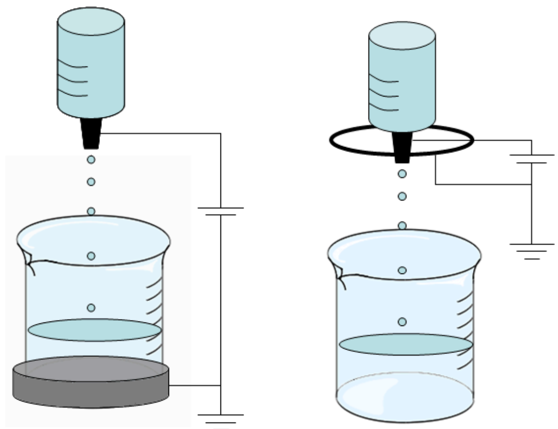


Figure 1 : droplet formation at 0kV and 6 kV (in ms)

In most articles related to the electrodripping (Poncelet, 1994), the electric potential is applied between the tip (generally a metallic needle) and the receipting solution or a plate (Figure 2a). A modified design was proposed where the potential is applied between a ring and the tip (Figure 2b).



a. plate connexion b. ring connexion

Figure 2 : Electrodripping set-up

The figure 3 presents some tests done with this two designs. In function of the applied potential, the evolution of the size may be described by diameter without electric potential d_o, a decrease fitting well on the equations above and characterizes by a critical electric potential Uc, leading to a minimum droplet diameter d_m.

Switching from the plate design to the ring design does not obviously modify the diameter without electric potential, the minimum diameter d_m seems also not strongly affected. However, the critical potential is lower for the ring design. The difference seems linked to the distance between the tip and either the ring or the liquid surface (Figure 3). It must be point out that the ring may be placed higher than the tip end.

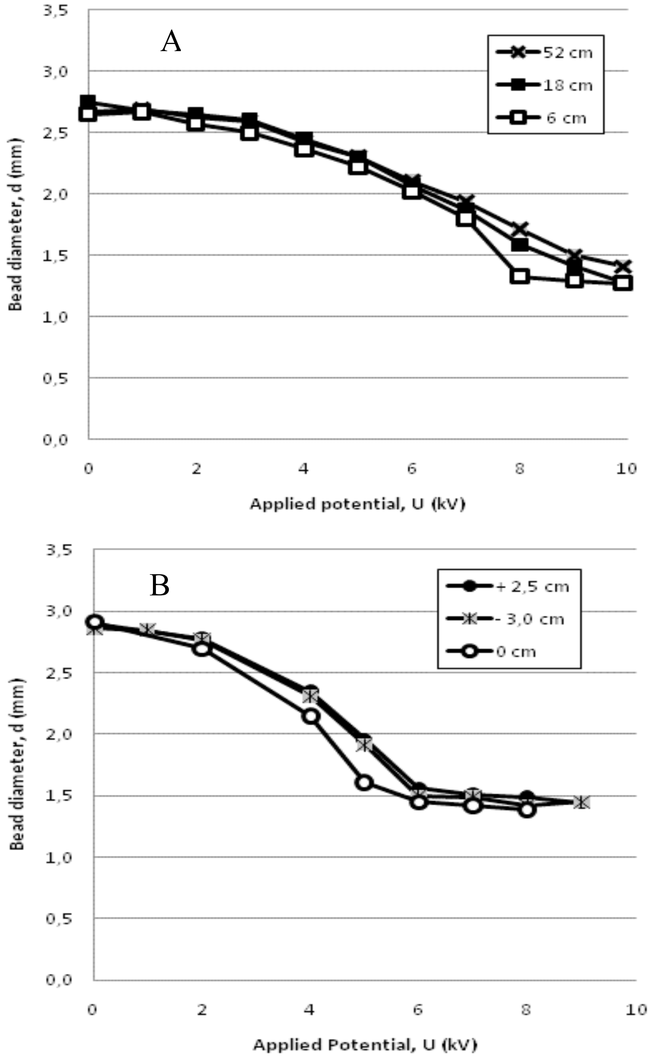


Figure 3 : Influence of the electrodripping set-up on the droplet size (distance between the end of tip and either (A) the surface of the receipting bath or (B) the ring).

The dimension of the ring (both external and internal diameter) seems not to affect the droplet diameter (data not shown). In contrary, the diameter of the tip seems to influence greatly the size of the droplets for all electric potential (Figure 4). Both diameters without electric potential d_o and minimum diameter d_m decrease mainly proportionally to the tip diameter. Moreover, the critical electric potential increases with the tip diameter.

CONCLUSIONS

Using the ring set-up with the ring place on top of the tip may allow to design a system where both tip and ring will be incorporated in a single isolating block, insuring safety without box around the system. This will provide more freedom for the manipulator.

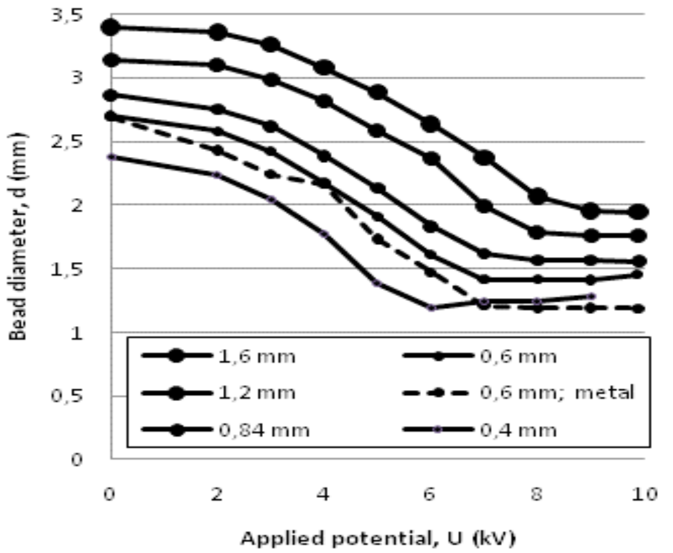


Figure 4 : Influence of the internal tip diameter on the droplet size

The liquid flow rate does not affect noticeably the droplet size at null electric potential but both the critical electric potential and the minimum diameter (Figure 5).

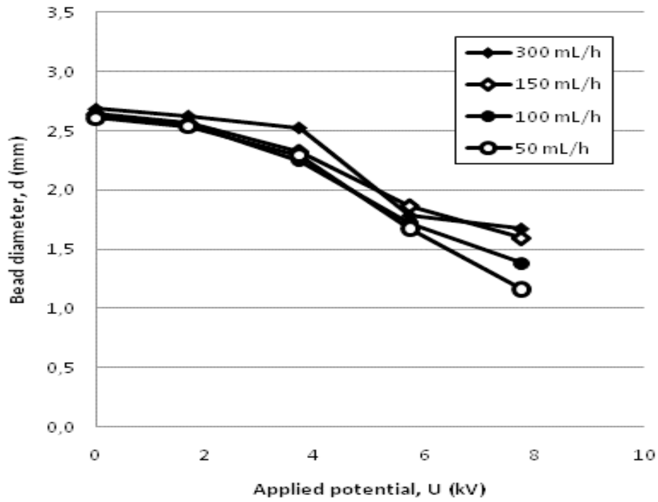


Fig 5 : Influence of the liquid flow rate on the droplet size

Further works are planned, especially using fast video recording to understand how each factor affect the size and provide a more complete modeling of the electrodripping process. This work will be extended to different encapsulation processes, and to a range of physico-chemical properties of the solutions.

REFERENCES

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