A SHORT REMARK ON ELECTRIC CURRENT IN THE ELECTROSPINNING PROCESS

by

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This paper suggests an approximate formula predicting the electric current in the electrospinning process or bubble electrospinning process. It reveals that the jet radius and surface charge density also affect the electric current greatly.

Key words: *electrospinning, bubble electrospinning, current*

Introduction

Electronic current is an important factor in electrospinning and its various modifications, such as the bubble electrospinning. Bhattacharjee *et al.* [1, 2] suggested the following empirical equation $I \approx EQ^{0.5}K^{0.4}$, where I is the current flowing through a jet, E – the field strength, Q – the flow rate, and K – the conductivity of the solution. This equation, however, requires much improvement to meet various conditions.

Dimension analysis

Using the dimension analysis, we assume that the current can be expressed as $I = I(E, Q, K, \sigma, r) \propto E^a Q^b K^c \sigma^d r^e$, where a, b, c, d, and e are constants. By a simple calculation, we find that:

$$I \propto (r^2 KE)^a \left(\frac{\sigma Q}{r}\right)^{1-a} \tag{1}$$

or

$$I \propto r^{3a-1} K^a E^a \sigma^{1-a} Q^{1-a} \tag{2}$$

From equation in paper [3-6] we have $I = \pi r^2 KE + (2\pi\sigma Q)/r \geq (2\pi^2 rKE\sigma Q)^{1/2}$. It is obvious that $a = 1/2$ is valid for the condition:

$$\pi r^2 KE = \frac{2\pi\sigma Q}{r} \tag{3}$$

Generally the current and applied voltage has the following scaling law [7] $I \propto E^\beta$, where β is a constant. We, therefore, have the formula for predicting the current:

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$$I \propto (r^{3a-1} K^a \sigma^{1-a} Q^{1-a})^{(\beta-a)/\beta} \tag{4}$$

Conclusions

From the dimension analysis, we can conclude that empirical equation in [2] might be valid for a special case, while eq. (2) or eq. (4) is valid for all cases in electrospinning or its modifications including bubble electrospinning [3]. The current depends upon jet radius and the surface charge density as well, which are not included in empirical equation [2].

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