

## ELECTROSPINNING AND MAGNETIC FIELD

Pavel POKORNY, Julie SOUKUPOVA, Petr MIKES

Technical university of Liberec, Studentska 2, 461 17 Liberec, Czech Republic, pavel.pokorny@tul.cz

### Abstract

There is a probability that electrospinning generates magnetic field. The influence of magnetic field on the process is still unknown. This experiment was carried out to investigate the influence of magnetic field on the trajectory of the nanofibrous jet. Helmholtz coils were used as a source of variable magnetic field and its influence on electrospinning process was studied.

**Keywords:** electrospinning, electromagnetic field, Helmholtz coils, magnetic fluid, liquid jet

### 1. INTRODUCTION

Here we report about the observation of influence of magnetic field on the electrospinning. It is proved that liquid jet is electrically charged and charge is moving between electrodes and therefore generates magnetic field. The interaction between magnetic field of Earth and magnetic field of liquid jet was studied as well. Effect of Lorentz force on charge's movement in magnetic field was explored.

### 2. EXPERIMENTAL

The Helmholtz coils is a good instrument for investigation of influence variable magnetic field on the charged liquid jet. Helmholtz coils with the incorporated electrospinner was designed and created. (Fig. 1). Laboratory

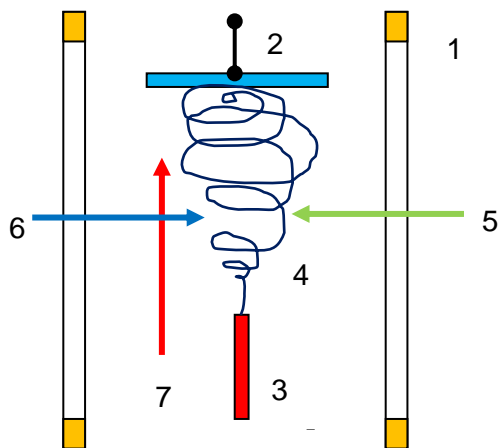


Fig.1 Helmholtz coils

spinning device including 1-Helmholtz coils, 2-collector, 3-spinning electrode, 4-liquid jet, 5-vector of magnetic induction of Helmholtz coils, 6- vector of magnetic induction Earth's magnetic field, 7- vector of electric intensity. Magnetic induction was measured by Gaussmeter HIRST GM-08-0361 and it is ranged from 0 to 563  $\mu\text{T}$ . Electric current through the coils was measured by multimeter FLUKE 187. Six experiments was carried out with this equipment. Parameters of each configuration and dimensions of the nanofiber layers obtained are shown in **Table 1**. The 12% wt aqueous solution of PVA as non-magnetic material for spinning was used. Measurement of electric current in liquid jet can be found in [1,2]. Dependence of influence magnetic field to liquid jet trajectory was sought. In case of positive influence of magnetic field the pattern sizes of nanofibrous layer will be significantly different (strong magnetic induction – large diameter of nanofibrous layer – thinner

nanofibers). Results are shown in the **Table 1**. and in the **Figure 2**. But differences in values of parameters in **Table 1**. are very small. Intensity of the magnetic field does not affect the diameter nanofibrous layer. Significant difference is in diameters of nanofibrous layers for different high-voltage polarity. This phenomenon can be explained by the influence of electric wind between the electrodes of spinneret [2], [3]. Electric wind of negative polarity is stronger than the wind positive polarity. There is larger diameter of the nanofibrous layer in the case of a negative wind.

**Table 1** Measurement parameters in a magnetic field.

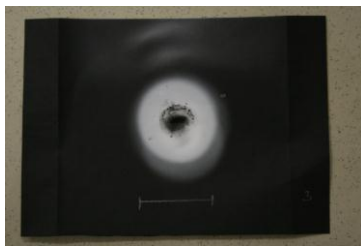
Number of probe	Magnetic induction [ $\mu\text{T}$ ]	Voltage on the spinning electrode [kV]	Electric current through liquid jet [ $\mu\text{A}$ ]	Weight of fibers [g]	Diameter of fibers [nm]	Diameter of nanofibers layer [cm]
1	19	+20	6,6	0,0128	168,77 $\pm$ 35,18	5,08 $\pm$ 0,23
2	0	+20	4,2	0,0252	179,49 $\pm$ 44,46	5,57 $\pm$ 0,15
3	563	+20	10,8	0,0185	144,88 $\pm$ 33,77	5,66 $\pm$ 0,11
4	19	-20	11,5	0,0078	175,23 $\pm$ 43,42	13,6 $\pm$ 0,28
5	0	-20	6,1	0,0119	136,43 $\pm$ 35,36	11,9 $\pm$ 0,13
6	563	-20	9,3	0,0082	126,9 $\pm$ 35,13	11,7 $\pm$ 0,17



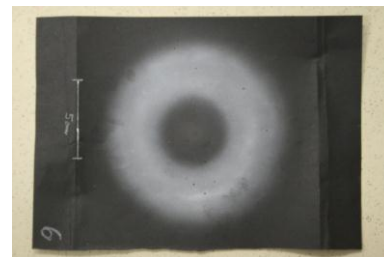
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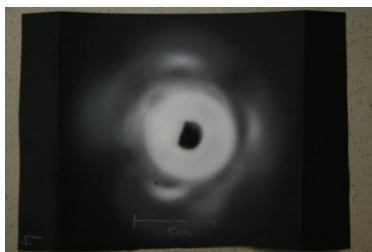
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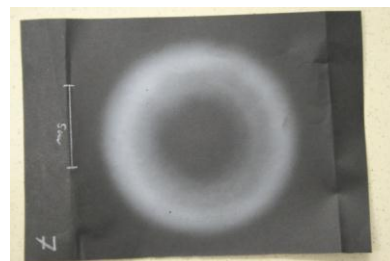
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5



3



6

**Fig. 2** The shape of the nanofiber layer after spinning in a magnetic field..

The line in the figures has a length of 5 cm. The Images are numbered consistently with **Tab.2**.

The samples 1, 2 and 3 are made with a positive electrode for spinning voltage +20 kV;  
 1- magnetic induction 19  $\mu\text{T}$ , 2 – magnetic induction 0  $\mu\text{T}$ , 3 – magnetic induction 563  $\mu\text{T}$ .  
 The samples 4, 5 and 6 are manufactured by spinning a negative electrode at a voltage -20 kV;  
 4 – magnetic induction 19  $\mu\text{T}$ , 5- magnetic induction 0  $\mu\text{T}$ , 6 – magnetic induction 563  $\mu\text{T}$ .

### 3. CONCLUSION

There is a minimal effect of the magnetic field on the electrospinning process which is important for construction of spinning equipment and its position. It is not necessary to solve the magnetic shielding process in the case of non-magnetic solutions. It is not possible to control the storage of nanofibres using magnetic fields in the case of non-magnetic solutions.

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### LITERATURE

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