

Modification of the properties of animal fibers using dielectric barrier discharge at atmospheric pressure

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The modification of animal fibers using Diffuse Coplanar Surface Barrier Discharge (DCSBD) at atmospheric pressure was investigated. The aim is to replace chemical pickling before felting with plasma treatment of animal fibers. For the subsequent analysis, the surface structure of fibers was used scanning electron microscope (SEM). Using the Washburn method the absorption of fibers over time was measured, for different treatment times in the tens of seconds.

DCSBD is a special type of dielectric barrier discharge, which was developed by the research group of prof. Cernak. Diffuse Coplanar Surface Barrier Discharge (DCSBD) works at atmospheric pressure in open air [1]. It is possible to add oxygen or nitrogen to the apparatus for better discharge properties. The experimental set-up consists of parallel metallic electrodes embedded in ceramic, which is shown in figure 1. DCSBD generates a non-isothermal cold plasma. This type of the plasma source operates at the frequency 15–40 kHz. The discharge area is 8,5 x 20 cm and the discharge power can be 50–600 W, in our case we used 400–600 W. Plasma treatment using DCSBD changes properties of material from hydrophobic to hydrophilic. The DCSBD discharge is applicable in treatment of non-woven textiles, wood, silicon wafers [2], foil, fibers used in concrete [3] etc.

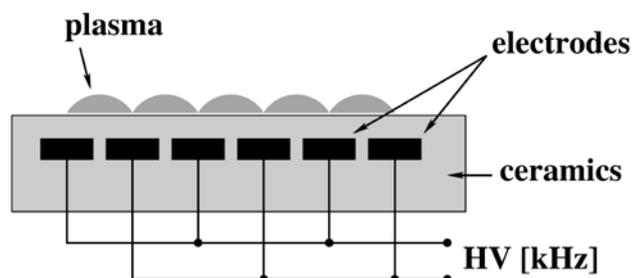


Fig. 1: Schema of experimental set up for DCSBD discharge.

In cooperation with the TONAK company we solve the problem of modification way of animal fibers before felting. TONAK is engaged in processing of animal fibers and manufacturing of felt hats. Currently, a chemical method for fiber modification before felting is being used. The chemical method is costly, environmental unfriendly and intrusive to the health of employees. It consists of pickling the fibers in a mixture of strong acids for a few minutes, being followed by drying the fibers in a tunnel kiln.

We try to replace the chemical method with the treatment of fibers in a plasma discharge. The plasma treatment of fibers limits the use of chemicals and energy consumption .

To analyse the treated animal fibers, we used a scanning electron microscope (SEM) technique and the Washburn method. Prepared samples of rabbit fibers were measured on the SEM [4]. Through SEM measurements there was found no difference in the surface structure between untreated and treated fibers, as you can see on figures 2,3.

The Washburn method seems to be the preferable method for diagnosis of the treated fibers. The Washburn method consists of measuring the absorption of water into the fibers in a special apparatus [5]. We have observed the dependence of mass of water soaked to the fibers on time. The measurement procedure is as follows: plasma treated fibers are filled into a glass tube with an open bottom, the fibers are compressed in a defined way and the same mass of fibers is always used. The tube is suspended on laboratory balances

above the beaker with water. The bottom end of the tube with fibers is brought closer to the water level until contact occurs.

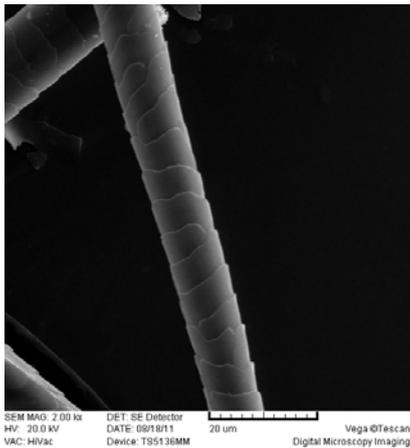


Fig. 2: Untreated rabbit fibers from the scanning electron microscope.

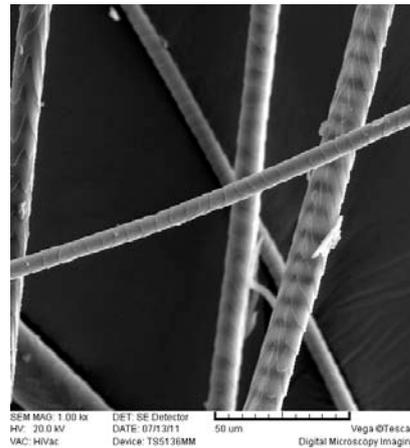


Fig. 3: Treated rabbit fibers (time of treatment 5 seconds) from SEM.

Dependence of different time of plasma treatment on amount of water soaked to the fibers has been studied. An example of a measurement - a comparison of 40 s and 60 s treatment time - is shown in fig. 4. Untreated fibers are highly hydrophobic and do not absorb water. Relevant parameters are absorption rate and the amount of finally soaked water.

The SEM analysis did not reveal any difference between treated and untreated fibers. On the other hand the Washburn method seems much more promising.

We will further explore the method, test different treatment times and improve the experimental arrangement.

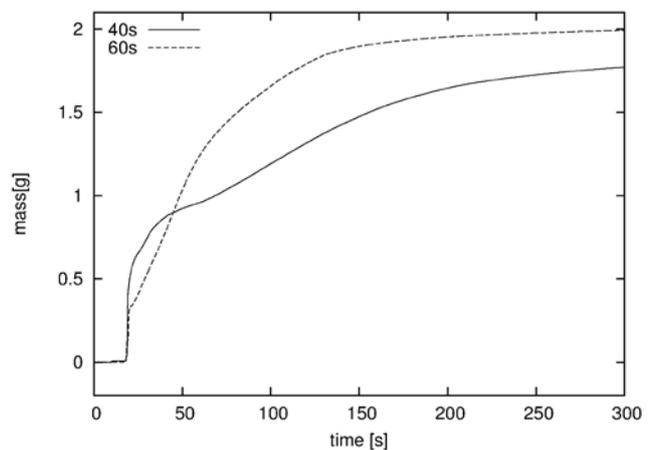


Fig. 4: Plot of Washburn method, time of plasma treatment was 40 s and 60 s.

Acknowledgements

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