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On the cover:
The "I Was Born in Warsaw" mural dedicated to Maria Skłodowska-Curie was commissioned by the Capital City of Warsaw and painted by Good Looking Studio on the wall of the public library in Lipowa Street in Warsaw.

Medical and Surgery Academy, Warsaw (now: the Polish Academy of Sciences, Staszic Palace) by F.H. Röber after L. Kapliński, woodcut engraving. Reproduction from the Archives of the Photographical Documentation Archives of the Institute of Arts, PAS.

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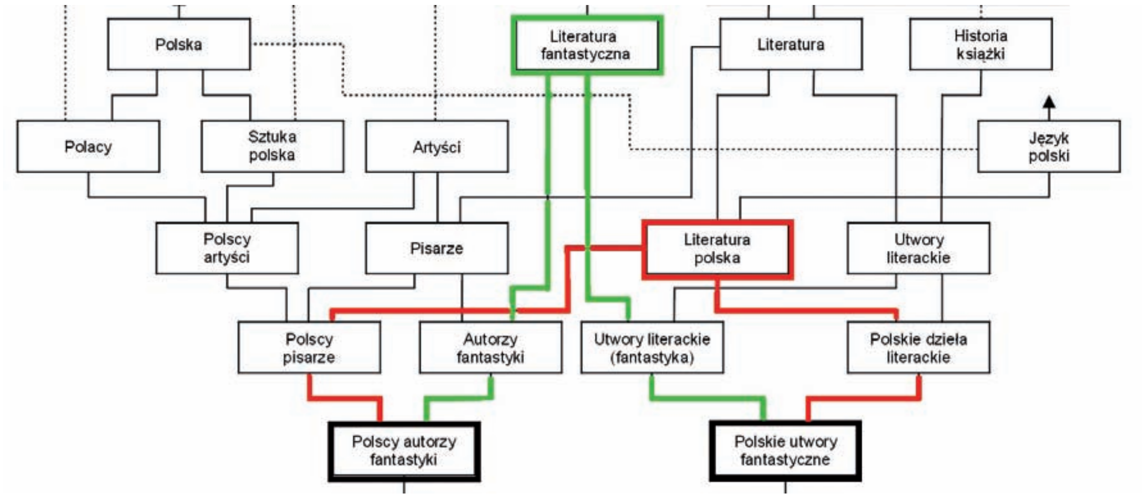

Fig. 3. According to our system, the Polish Wikipedia concepts "Polish fantasy authors" and "Polish fantasy books" share a common most specific supercategory "Polish literature," which describes them better than e.g. "Fantasy literature"

mation turns out to be particularly useful in cases where the textual-only information is of low quality and/or unavailable (as in case of book descriptions in typical library catalogues).

In our future research, we plan to investigate whether the user profile, describing the user's information needs, can also be taken into account as an additional dimension(s) in the document space, so that a conceptual framework for personalization of document clustering and document classification can be swiftly obtained.

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Nanofibers for medical applications at Biocentrum Ochota

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Nanotechnology is the rapid evolving science of manufacturing and utilizing extremely small particles and devices, sometimes as small as single atoms and molecules. People became interested in the nanoscale because it affects the properties of materials. A very high surface to volume ratio is one of the most remarkable features of nanomaterials, and is believed to be a key factor in the improvement of their properties. This can make materials more chemically reactive, and affect their strength or electrical properties.

Electrospinning of polymer fibers is one of the simplest and cheapest methods of producing nanomaterials. Electrospinning occurs when a high enough electric field is applied to the liquid jet of a polymer solution. Because of the action of the electrical stresses the jet is stretched by the bending instability and solidifies further on into an ultra thin fiber. Reducing the diameter into the nanometer range through a uniformly applied tensile stress gives rise to a set of favorable properties including a strong decrease in the concentration of structural defects, enhancing the strength of the fiber.

Early interest in nanofibrous nonwovens was driven by prospects for their use in developing new, lighter and stronger materials. The key feature that differentiates classic materials used in construction from nanomaterials is, in general, coarse-grained polycrystalline structure of relatively frequent structural irregularities and dislocations. Other prospective applications of nanofibers include: biological nanofilters, seamless clothing for special applications, and wind-driven aerodynamic profiles of a spider-web structure. The presence of numerous nanopores on the surface of the nanofibers is another key feature, facilitating their use in biomedical applications, such as drug delivery systems, nano-scaffolds for tissue engineering, and absorbable implants of skin or other tissues.

Electrospinning is based on the complex hydrodynamic and electrostatic interactions of charges moving at a rate of several meters per second in an electrostatically driven bending liquid jet of rapidly changing physical properties (elongation, solvent evaporation, crystallization). The nanofiber dynamics research that was first launched at the Institute of Fundamental Technological Research, Polish Academy of Sciences, back in 2003 was initially focused on process control. This led to the development of a computer model enabling selective analysis of the parameters crucial for the stability of the electrospinning process and fiber draw ratio (see Fig. 1). Experimental investigations have confirmed some of the correlations anticipated by the model. The impact of the physical properties of the polymer solution used and the electrical field applied on nanofiber formation was evaluated. However, it seems to be quite a difficult objective to strive to take account of all possible factors contributing to this highly unstable process. In many cases, therefore, selection of the process parameters is based on laborious collection of experimental data.

Fig. 1. Computer simulation of the electrospinning process. The fiber, represented as a chain of elementary charges drawn by the electric field towards the collecting electrode, exhibits a looping trajectory with an accelerating amplitude of deviations

The favorable mechanical properties expected from nanofibers drove our initial interest in the electrospinning process. However, tests carried out at our institute on individual fibers, fiber bundles, and nanofibrous mats have evidenced no apparent effect of stretching on the fibers' mechanical properties, as suggested by other authors. Young's modulus and the tensile strength measured for the majority of the samples tested were close to the values of standard materials. This effect may be caused by the free fall of not-completely-solidified nanofibers on the collector electrode. Within the initial phase of the electrospinning process the fibers are subjected to stretching, which orders their internal structure. However, during their deposition the nanofibers are likely influenced by a rapid structural relaxation. Analysis of the fibers' crystalline structure performed at our institute using the polarization-interference method has confirmed this hypothesis. Nevertheless, a simple method (patent pending 2010) of producing waterproof and mechanically resistant mats made of polymer nanofibers was developed during this research (comp. Fig. 2). Such nanofibrous mats are well suited for filtration and bio-separation.

Our current interest in polymer nanofibers focuses on biological and medical applications.

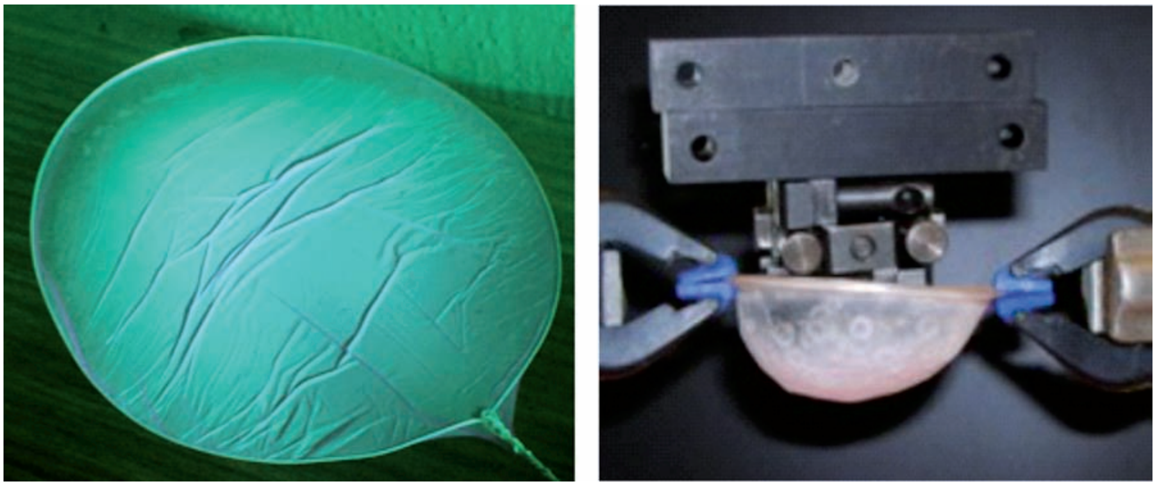

Fig. 2. Nanofibrous membrane of 65 mm diameter and ~0.05mm thickness is formed from bio-compatible polymer (PLLA) using rotating water surface as a collector (patent pending). The structure so obtained exhibits remarkable mechanical strength (over 500g load)

Nanofibers based on blood serum protein (BSA) were applied as a very permissive material for the construction of fluorescent probes for bio-diagnostics. Biocompatible nanofibers were also used to construct post-burn wound protective dressing, successfully tested on mouse skin. Nanofibrous mats have been applied to prevent finger liaisons as well as to facilitate maintenance of skin implants (in collaboration with Prof. B. Noszczyk – CMKP in Warsaw). Another research project deals with the use of electrospun nonwovens as ureter or urinary bladder regenerative implants (in collaboration with the group of Prof. T. Drewa – Collegium Medicum UMK in Bydgoszcz).

Electrospun nonwovens have recently been successfully applied as a dressing material in spinal neurosurgery. Scarring is known to be one of the major post-operative complications for neurosurgery. If it occurs, it may trap a nerve, so that when a patient moves the nerve becomes stretched, causing nerve damage, pain, and internal scarring of the nerve. This causes subsequent complications related to ingrowths of connective tissue onto the spinal canal. The formation of an astroglial scar is another serious postoperative complication of brain neurosurgery. The use of bio-absorbable isolative materials as anti-liaison protection and as possible carriers for neuroprotective drug delivery is expected to help in solving such problems. The nanostructured material acts as an anti-bacterial and anti-liaison barrier while enabling transport of oxygen, nutrients, and metabolites, facilitating the healing process of the surgical wound. The insulating material is gradually degraded leaving behind lactic acid, which does not adversely affect the surrounding nervous tissue. The neurosurgical application of nanofibrous

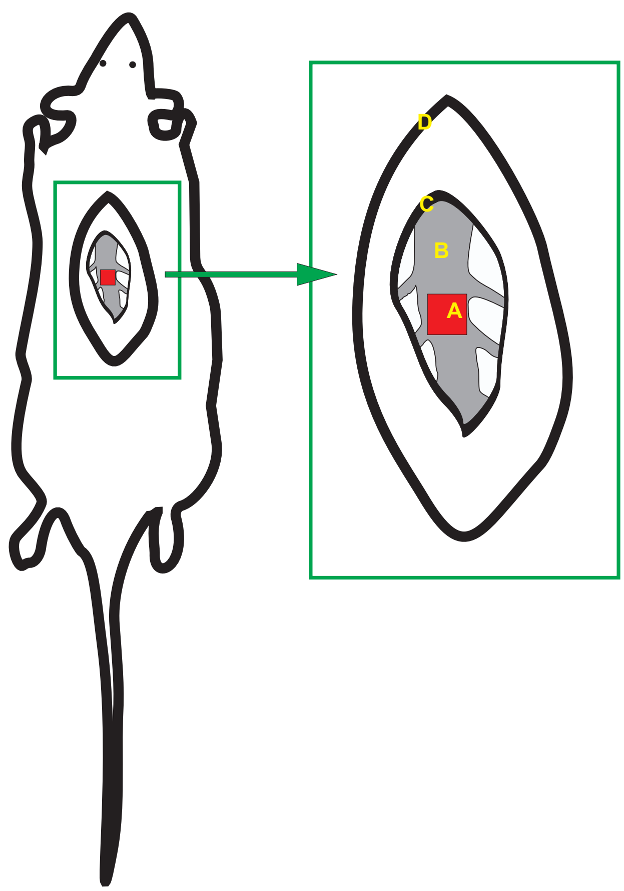

Fig. 3. Schematic illustration of laminectomy surgery, showing the place of application of the electrospun mat. A – nanofibrous mat, B – spinal cord, C – cut of spinal bones, D – cut of skin

mats is a joint project between the Institute of Fundamental Technological Research, Polish Academy of Sciences, and the Mirosław Mossakowski Medical Research Center. The application of poly(lactic acid) copolymers has yielded the first positive results. The mats were applied as a barrier to scar growth, placed into an open spinal canal (patent pending 2011) in the course of spinal laminectomy conducted on a rat model (Fig. 3). The membrane was placed on the surface of the exposed spinal cord and covered with the surrounding dura mater. Ultrastructural and immunohistochemical tests carried out after a certain period of time on dura mater and spinal cord specimens showed a lack of inflammation. Astroglials and connective tissue scars that could be potentially dangerous to regeneration were also shown to be absent. Bone fragments of the spine overgrew normally as part of the healing process. The outcome of this experiment raises expectations for the development of a clinically approved barrier material used to prevent post-operative complications commonly related to the scarring process following spinal surgeries.

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The Synthetic Aperture technique for tissue attenuation imaging

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Introduction

The attenuating properties of biological tissue are of great importance in ultrasonic medical imaging. It has been emphasized in many publications that ultrasound attenuation is closely related to the type and pathological state of the tissue. Investigations performed *in vitro* and *in vivo* have shown correlations between pathological changes in the tissue and variation of the attenuation coefficient. The liver is the most frequent example. The *in vivo* characterization of this organ is often restricted to its attenuation properties and it has been proved that the ultrasonic attenuation coefficient increases as the amount of pathological fat in the liver increases. Also, the study of excised cancer tissue has revealed differences in acoustic attenuation among cancer types and degrees of pathology. Saijo et al. (1996) employed a scanning acoustic microscope to measure five types of gastric cancer and reported different attenuation coefficient and sound speed compared to normal tissue. Bigelow et al. (2008) investigated the possibility of predicting premature delivery based on noninvasive ultrasonic attenuation determination in rats and in humans. Worthington and Shear reported that thermal coagulation of porcine kidney changes attenuation and Zderic et al. demonstrated strong attenuation changes in porcine liver related with HIFU treatment.

The long term goal of this study is to develop the attenuation parametric imaging technique and to apply it for *in vivo* characterization of tissue.