BASIC INFORMATION ON SUB-PROJECT	
NAME OF PROGRAMME/FUND	Scholarship Fund - Sciex NMS^{ch}
RESEARCH FIELD AND OTHER RESEARCH FIELDS INVOLVED (if applicable)	Physics
TITLE OF THE SUB-PROJECT	Exploring and Transfer of Plasma Nanocomposite Coatings for Sensor Applications (ExTraSens)
REGION OF THE CZECH REPUBLIC (according to the location of the home institution)	Prague
GRANT AMOUNT SPENT	141 433,30 CHF
INTERMEDIATE BODY	Swissuniversities
HOME INSTITUTION	Charles University in Prague Department of Macromolecular Physics
HOST INSTITUTION	Empa Materials meet Life
NAME OF THE FELLOW	Martin Drábik

ABSTRACT OF THE SUB-PROJECT	Metal/polymer composite coatings have been recently widely studied due to their possible applications in different areas, like electrical and optical coatings, in data storage and biomedical applications. Magnetron sputtering and plasma polymerization are among the important in-situ techniques deployed for preparation of the coatings where metal nanoparticles are incorporated into a plasma polymer matrix. Low deposition rates and restrictions in deposited area are the key factors which limit the mentioned coatings from a wider utilization by the industry. Recently, Empa transferred both plasma polymerization and sputtering processes to the textile industry. The proposed challenging project will use the experience and follow a similar trend. It aims in developing technology for the deposition of plasma nanocomposite coatings and their transfer to industrial-size reactors and exploring the potential of such coatings for sensor applications. Changes in the nanocomposite coatings will be observed and metal ion release in aqueous environments will be studied. The project time schedule is divided into several work packages according to the target study. The set-up of a proper lab-scale plasma reactor and launch of an appropriate deposition process will be the first task. Different metal targets (gold and silver) and reactive gases mixed with hydrocarbons and HMDSO were selected. The deposition process and properties of the coatings will be optimized within first half year of the project. Resistive, capacitive and inductive measurements will close the first section of the project which should lead to a nanocomposite structure applicable as an efficient sensor. The sensors will be further investigated in an aqueous environment for a particular application. The last and the most important part will be the transfer of the deposition conditions obtained for the lab-scale reactor into an industrial web coater for scaling-up of the process which will be interesting for industry.

MAIN RESULTS	The nanocomposite coatings formed of silver particles embedded in an oxidized amorphous hydrocarbon plasma polymer matrix (Ag/a-C:H:O) were chosen as the most promising material for the sensors in the bio-medical field. The deposition process of the coatings was fully characterized. Deposition parameters suitable for later industrial up-scaling were obtained. The composition and stability of the process was controlled by an in-situ monitoring system. By full control over the deposition process we could deposit coatings with various structures and compositions. It resulted in formation of sensors with various sensitivities towards the measured stimuli since the electrical properties are highly dependent on their microstructure. The desired film structure of the sensors was achieved. After the optimization of the film properties, the main concern was the transfer of the electrodes and nanocomposite coatings from plane substrates to monofilament polyethylene terephthalate (PET) textile fibers as the first step towards the industrial application. A novel masking system was designed and constructed. The masking was tested by electrical measurements and its quality was controlled by electron microscopy. As the last step, stability of the coatings upon aging in air and in water was studied. Several different aging processes were observed and described in the nanocomposite films in the dependence on the microstructure of the coatings. The most important result is that the films react to the presence of water and the measured difference in conductivity of the samples in dry state and in water is so high that it assures a proper utilization of the films in sensor applications. At the end of the project, suitable deposition conditions and structure of the nanocomposite sensors (both humidity and distortion) were obtained. The coatings were transferred onto monofilament PET textile fibers using a specially designed masking system. The deposition process of the sensors is ready for an industrial application. The success of the project was so high that the obtained results were further used in another project aimed for preparation of biomedical textiles for paraplegic and elderly people in cooperation with University Hospital Zurich, ETH Zurich and Swiss Paraplegic Centre.

DATE OF REALISATION OF THE FELLOWSHIP	1.8.2011 - 31.1.2013
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