STSM Scientific Report

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Introduction:

Consumer trends for high quality food without any preservatives or with less processing technologies increase the demand for novel packaging technologies to better protect the quality of food through packaging. Active packaging is an innovative approach that has an active protection function either by releasing the substances to the food or absorbing the substances from the food or the headspace (Yildirim 2018). Oxygen scavengers is one of the most important active packaging technologies which can remove the oxygen from the headspace of the packaging and therefore can prevent any oxidation in food or mold growth in food. We developed a novel oxygen scavenger system based on palladium catalysis to remove the oxygen remaining in the headspace after the modified atmosphere packaging. Palladium catalyses the oxidation of hydrogen in the presence of oxygen (Figure 1).

$$H_2 + ½\ O_2 \xrightarrow{Pd} H_2O$$

Figure 1: Catalytic oxidation of hydrogen with oxygen

We have developed, optimized and characterized the palladium coated active films (Yildirim 2015; Röcker 2017) and showed its potential for food packaging applications (Hutter 2016).

Concerning the food contact legislation we aim to have a functional barrier between the food and the palladium coating to inhibit any migration from the active surface to the food or the other way around any impact of food in the palladium catalysis. Such a food contact layer should be highly gas permeable in order not to reduce the speed of the reaction so that oxygen can be removed from the headspace before it has an impact on the quality of the food.

Purpose of the STSM:

Electrospun nanofibers have potential to be applied as a food contact layer (Cakmak 2018). Such matierals have pore sizes below 100 nm and the transport properties of liquids, moisture and gases can be tailored individually by selecting processing parameters and appropriate materials. We have coated the packaging materials with palladium at ZHAW and within the scope of the STSM we aimed to use the electrospinning and electrosraying technologies at the host institution to cover the palladium surface with electrospun nanofibers as food contact materials.

Description of the work:

PET/SiOx films were coated using magnetron sputtering technology as described elsewhere (Yildirim 2015). The silk fibroin and collagen were directly deposited on the PET/Pd composite in a continuous

process using electrospinning technique (Nanospinner, Imkasan, Izmir, Turkey) with a wire electrode. Materials used for electrospinning and the coating conditions are described below.

Silk fibroin preparation: Silk Fibroin (SF) was obtained from the Ege University Chemical Engineering Department (Izmir, Turkey). Silk fibroin was solved in formic acid (98+ % purity , Merck, Germany) to a final concentration of 80 mg/ml.

Collagen preparation: Collagen was extracted from sheep foot. Collagen electrospinning solutions were prepared with 6.3% (w/v) freeze-dried collagen dissolved in 50% (v/v) acetic acid (HAc, 99%, Sigma Aldrich, St. Louis, USA). Solutions were allowed to cool on the bench until room temperature (20 °C) was reached, before electrospinning.

The prepared electrospinning solutions were loaded into a 10 ml syringe with a blunt end nozzle, controlled by a syringe pump. The solution was pushed through a capillary blunt steel needle at a constant speed (0.2 ml/h). The spinning conditions were kept constant with a distance of 10 cm between the Taylor cone and the collector at room temperature (20 °C). The voltage was set at 25 kV for silk fibroin and 18.7 kV for collagen. Fibers were collected on an aluminum plate for 15 or 30 min for silk fibroin and 15 min for collagen and peeled off as a mat. Fibers were stored at room temperature until analysis was carried out.

Future collaboration with the host institution

Through this STSM a collaboration between the home and host institutions was started. Both institutions aim to continue this collaboration in future in the area of active packaging and electrospinning/electrospraying technologies as well as in other research areas of food and packaging.

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