DEVELOPMENT OF A TEXTILE UV-SENSOR

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Abstract

In our research we focus on the development of smart textiles with novel production techniques like digital inkjet printing. Through digital inkjet printing a flexible textile functionalization process for small batches with a reduced ecological footprint can be realized. Next to the minimized consumption of energy, water and chemicals, the functional chemistry can be applied locally and with complex designs while retaining the textile properties.

A changing environment and a coupled increasing demand for protection mechanisms are the main drivers and motivation behind the sensor technology in smart textiles, combined with the demand for lightweight products and highly integrated functions. For this purpose, chromic materials provide excellent properties to function as flexible sensors. By displaying a reversible colour change the user is alarmed of environmental circumstances and dangers. Colour change is caused by activating external stimuli which can range from a shift in pH-value [1] to the presence of highly toxic gases like carbonmonoxide or augmented UV-radiation.

Today, the use of photochromic materials in ophthalmics is well established. A wearable UV-sensor as protection mechanism for harmful sunlight would synergize this technology and traditional textiles. The integration of photochromic dye in textile structures through various standard textile production techniques has proven to be successful; fibre integration, dyeing and screen-printing [2,3]. At this point, the stabilization of photochromic materials to increase their fatigue resistance still remains a challenge in research [3] .

In this work, different photochromic compounds are integrated in a binder formulation for textile printing and combined with various light stabilizing agents. Through spectrophotometry the colour intensity, together with the repeatability of the UV-induced colour change of printed textiles is examined, as well as the materials' suitability as textile sensor is characterized.

Introduction

Photochromic materials provide a dynamic colour change triggered by UV-radiation. UV-induced reversible molecular rearrangement results for most chemical photochromic classes in a change from colourless state (A) to coloured state (B) (*see Figure 1*). Depending on the compound class the reverse reaction is either thermally driven (T-type) or influenced by irradiation with a different wavelength of light (P-type) [4].

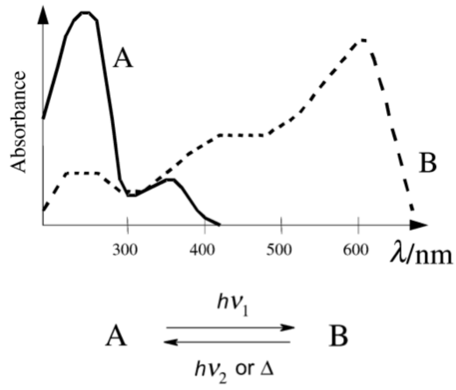

Figure 1: Difference in absorption spectra of colourless state A and coloured state B [5]

In comparison to ophthalmics where photochromic materials are embedded in polymer resin, the poor photostability of chromogenic materials applied on textiles restricts the use in technical applications at present. The enhanced exposure of photochromic prints makes them more sensitive towards environmental impact and more prone to degradation. In order to use photochromic materials for smart textiles, mechanisms have to be found to increase the photostability and therewith the lifetime of the dynamic colour performance.

Experimental

In this work, two photochromic dyes of the spiropyran and spirooxazine class have been studied to characterize their suitability as UV-sensors and specifically to be incorporated in an inkjet ink formulation. To begin with, the dyes have been analyzed with UV-vis spectrophotometry and integrated in a commercial aqueous acrylate binder formulation for screen-printing. The printing paste has been combined with three different light stabilizers; a hindered amine light stabilizer and two UV-absorbers, to investigate their effect on the intensity and repeatability of the reversible colour change. Colour assessment has been repeated after simulated household washing.

Challenges

The aim of these experiments is to establish a basis for inkjet ink formulation with the option of UV-curing. Curing with UV-light in inkjet printing disposes of several advantages such as low-energy curing, emission of little to no volatile organic compound solvents, no water consumption and minimized risk of nozzle blockage [6,7]. The interplay of activation wavelengths of the photochromic materials in contrast to the absorption maximum of the photo initiator, nevertheless, is a challenge to be solved.

Furthermore, indicate these experiments mechanisms for photostabilization of the active materials to increase the lifetime of textile UV-sensors.

Acknowledgements

Sina Seipel gratefully acknowledges the support of Borås Stad and Sparkbankstiftelsen Sjuhärad for enabling this research.

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