Fluorescence microscopic and spectroscopic monitoring of degradation processes upon polymer ageing

Katrin Hoffmann, Harald Tschiche, Ute Resch-Genger
Federal Institute for Materials Research and Testing, Richard-Willstaetter-Str. 11,

D-12489 Berlin, Germany; E-mail: katrin.hoffmann@bam.de

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The majority of all routinely used methods to assess polymer aging are based on destructive tests and methods. Early indicators for the deterioration of polymer materials are e.g., physical or mechanical properties like tensile strength, adhesion, brittleness, and color.[1]

It is well-known, however, that predominantly chemical changes are the underlying process of the physical changes that occur in organic materials upon aging over time. Typical initial steps during polymer degradation are crosslinking or chain breaking, alteration of autofluorescence, "yellowing" or bleaching caused by the formation of new functional groups.
A straightforward strategy towards the sensitive detection and monitoring of chemical changes in the course of polymer aging is based on non-destructive optical measurements. Luminescence techniques, one of the most sensitive spectroscopic methods are the method of choice. [2,3]

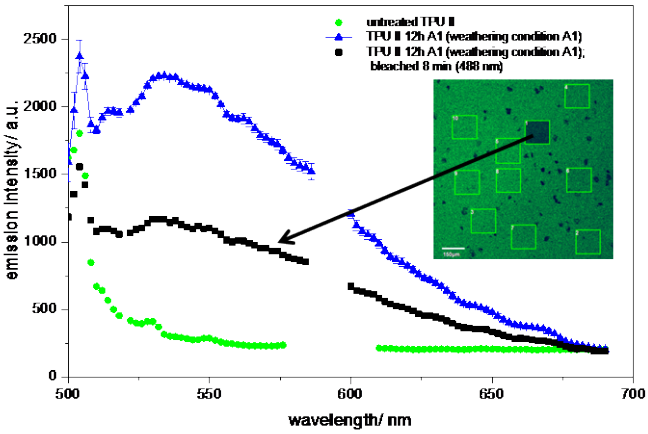

Fig. 1: Microscopic and spatially resolved fluorescence spectroscopic monitoring of accelerated aging of a TPU polymer.

Here, we present first results of luminescence-based monitoring of polymer degradation induced by different environmentally relevant weathering factors (e.g. humidity and UV exposure). Our studies include fluorescence spectroscopy as well as spectral scanning confocal fluorescence microscopy and clearly demonstrate the possibility to follow accelerate-aging processes by luminescence detection.

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[2] B. Röder, E.A. Ermilov, D. Philipp D, M. Köhl, *Observation of polymer degradation processes in photovoltaic modules via luminescence detection*. In: SPIE 7048, Reliability of Photovoltaic Cells, Modules, Components, and Systems, 2008
[3] K. Hoffmann, U. Resch-Genger, R. Mix, J.F. Friedrich, *Fluorescence Spectroscopy Studies on Plasma-Chemically Modified Polymer Surfaces with Fluorophore Labeled Functionalities* Journal of Fluorescence 16: 441-448, 2007.