Introduction

Synthetic fibers form an important part of the textile industry, the production of poly(ethylene terephthalate) (PET) alone surpassing that of cotton. A disadvantage of synthetic fibers is their low hydrophilicity. Polyester fibers are particularly hydrophobic. This affects the processability and functionalisation of the fibers. A novel and promising alternative is the use of enzymes in surface modification of synthetic fibers. Synthetic materials have generally been considered resistant to biological degradation; recent developments at different research groups demonstrate that enzymes are very well capable of hydrolyzing synthetic materials.

Focus & Aim

The general aim is to functionalize (bio)polymeric textile materials using modern biotechnology. Enzymatic surface modification of textile materials involves processing of fibers or (bio)polymers to modify the physical chemical surface properties or the introduction of functional groups on the surface. The research presented focuses on specific enzymatic surface modification of PET to obtain functional structured surfaces.

Cutinase

Cutinases from Fusarium solani pisi, Fusarium oxysporum and Thermobifida fusca are frequently studied and seem to have good potential for enzymatic surface modification of PET. Cutinase (EC 3.1.1.74) is a serine hydrolase (dimensions 45/30/30 Å) specific for the hydrolysis of cutin (a biopolymer in the cuticle of higher plants). Cutinase is more active towards amorphous regions of PET, and has little activity towards highly crystalline of PET. Cutinase is able to increase hydrophilicity of polyesters by hydrolysis of ester bonds. Hydrolysis of PET by cutinase is via an endo-mechanism, resulting in new carboxyl and hydroxyl groups in the polymer surface.

NaOH hydrolysis is also via hydrolysis of end groups which results a smaller increase of new carboxyl and hydroxyl groups in the polymer surface. The enzymatic process thus facilitates the functionalisation processes. Enzymes will not penetrate into the material, and therefore not affect the favorable bulk properties contrary to chemical treatments. NaOH hydrolysis results in pitting corrosion, which is not seen in the enzymatic treatment.

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<th>Treatment</th>
<th>Contact angle</th>
<th>Mechanisms</th>
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<tr>
<td>Untreated</td>
<td>~75</td>
<td>Endo</td>
<td>Introduction of new hydrophilic groups</td>
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<tr>
<td>Cutinase</td>
<td>~58</td>
<td>Endo</td>
<td>Little or no introduction of hydrophilic groups</td>
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<td>NaOH</td>
<td>~45</td>
<td>Hydrolysis</td>
<td>Endo</td>
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Cutinase modified PET samples were functionalized by alkylation with 2-(bromomethyl) naphthalene (BrNP) and analyzed using fluorescence spectroscopy. Photoluminescence emission and excitation spectra were recorded using a fluorescence spectrometer (λ from 200-850 nm). Total photoluminescence intensity was measured using an integrating sphere.

Functionalised surfaces

The fluorescence results indicate that the cutinase treated PET films are more alkylated with BrNP. The results. The results confirm that we are not just able to modify PET films through surface hydrolysis, but that we can actually functionalise the modified PET surface as well. In this paper we functionalized the surface by fluorescent hydrophobic groups.

Figure 1. The emission spectra of 6 samples: A= PET-Cr + BrNP, B= PET-Cr + Enzyme + BrNP, C= PET-Am + Enzyme + BrNP, D= PET-Cr + Enzyme + BrNP, E= PET-Am + Enzyme + BrNP and F= PET-Cr + NaOH + BrNP.

Figure 2. The total emission intensity of samples (% from 350nm) as measured with an integrating sphere. A= PET-Cr + BrNP, B= PET-Cr + Enzyme + BrNP, C= PET-Am + Enzyme + BrNP, D= PET-Cr + Enzyme + BrNP, E= PET-Am + Enzyme + BrNP and F= PET-Cr + NaOH + BrNP.

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