# Soft Functionalization of PET for the Design of Bioactive Compliant Vascular Graft

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**Introduction:**

Synthetic vascular grafts made from polymers such as polyethylene terephthalate (PET) woven fibers (Dacron$^{TM}$) have been used for decades to replace diseased arteries with large diameter (>6 mm).[1] However, these grafts did not prove to be efficient for smaller diameter vessel substitution, due to their considerably low mechanical compliance when compared to native arteries[2] and their poor bioactivity (i.e., lack of beneficial cell–material interactions, leading to platelet adhesion).[3] Novel nonwoven structures made of PET microfibers were studied as vascular substitutes. Such structures were already shown to match mechanical properties of native arteries, in terms of compliance and burst pressure.[4] We believe that the biofunctionalization of these structures would likely improve cell adhesion and reendothelialization on those PET grafts. As the first key-step towards the design of biofonctionnalized scaffolds, a new treatment was used to bring moieties onto the PET structures while preserving their mechanical properties.

**Materials and Methods:**

PET structures were produced via a melt-blowing process, as previously described by Moreno et al.[4] Both 6-mm wide PET scaffolds and corresponding planar mats were made. The PET mats were treated with two different chemical treatments: aminolysis with polyvinylamine (PVAm) or ethylenediamine (EtDA). Those treated PET mats were characterized in terms of amino group density and tensile properties. Amine densities were assessed through the Orange II assay.[5] SEM imaging was also performed to assess the degradation of the mats. The 6-mm wide scaffolds were only treated with the compound of interest, namely PVAm. Their compliance under physiological pulsatile pressure (80/120 mmHg at 1 Hz frequency) as well as their burst pressure were evaluated. As an example of subsequent functionalization, L-cysteine was grafted onto PVAm-treated structures.

**Results:**

To address the limitations of common chemical treatments of PET (i.e. bulk degradation), PVAm was used as an alternative reagent for PET amination. PVAm showed to efficiently bring amino groups onto the PET mats up to 80 µmol/g, among which 70% were available for L-cysteine functionalization. Similar densities could be obtained with the commonly used reagent, namely EtDA, but at the expense of the tensile properties and with strong bulk degradation (Figure 1). The PVAm treatment was then applied to our 6-mm wide scaffolds, and proved to be suitable for different structures since identical reaction conditions led to equal amino group densities. Of huge interest, the PVAm treatment allowed to preserve the mechanical properties of the pristine scaffolds (Figure 2). For the chosen conditions, the PVAm-treated structures showed a compliance of $8.5 \pm 2.8$ $10^{-2}$ $mmHg^{-1}$ and a burst pressure of $2443 \pm 249$ mmHg, which closely match those of native arteries ($9.6 \pm 0.6$ $10^{-2}$ $mmHg^{-1}$ and $3711 \pm 728$ mmHg).

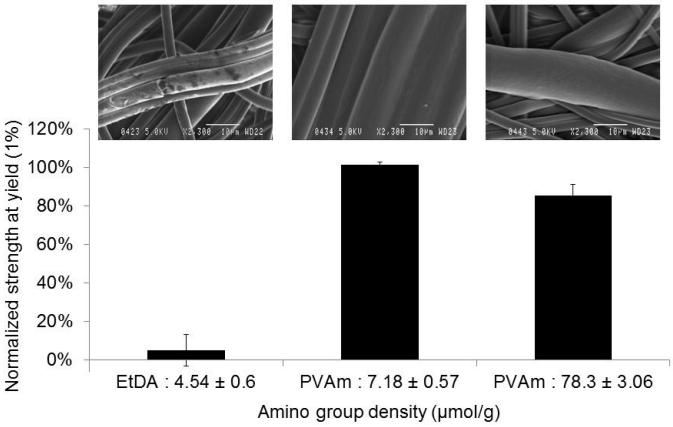


Figure 1. Comparison of EtDA and PVAm treatments (Orange II test, tensile testing and SEM imaging) Strength at yield was normalized with the one of pristine mats.

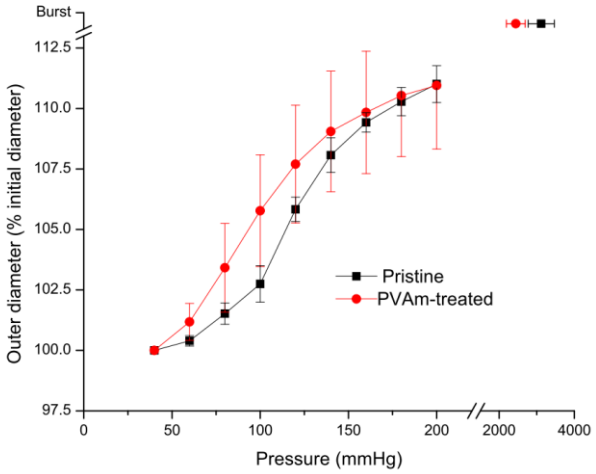


Figure 2. Comparison of PVAm-treated scaffolds (under conditions leading to 77.9 ± 2.44 µmol/g of $NH_2$) with pristine scaffolds under pressure and to burst.

**Discussion:**

Reactive moieties had successfully been brought onto compliant 6-mm wide PET scaffolds without affecting their key mechanical properties. Moreover, the successful grafting of L-cysteine makes the structures suitable for biofunctionalization strategies based on the oriented immobilization of cysteine-tagged peptides or proteins. Therefore, our non-damaging functionalization paves the way to biofunctionalized and compliant scaffolds allowing for efficient coverage with vascular cells.

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**References:**

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