Mechanical Testing of Single Electrospun PCL Fibers by AFM

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Aliphatic polyesters, e.g. poly(ε-caprolactone) (PCL), poly(lactide)s, poly(glycolide) and their copolymers, have shown a great potential for biomedical and pharmaceutical applications.
They may be applied in the field of tissue engineering or tissue regeneration as scaffold materials, on account of their remarkable compatibility with physiological medium. Moreover, due to the hydrolytic and enzymatic instability of their ester bonds, they are degraded in a physiological environment into non-toxic products, which make them outstanding candidates for short- to medium-term applications.

In this respect, nanometric fibers are highly interesting as their assembly mimics the extracellular matrix structure. Such nanofibrous materials can be prepared by electrospinning – this technique uses a high voltage to create an electrically charged jet of polymer solution or melt which leads to fibers formation – and can be applied as potential scaffolds, a.o. to form a temporary, artificial extracellular matrix.
A prerequisite to the application of any polymer as nanofibrous biomaterial scaffolds is the investigation of its mechanical strength. Indeed, the strength and deformability of nanofibers have been demonstrated to influence *in vitro* cell migration, proliferation, differentiation, along with cell morphology. Moreover, the structural integrity and the mechanical strength of the scaffold are very important for maintaining the desired pattern before the new tissue is formed.

However, mechanical testing of fibers and fibrils with diameter less than one micron is challenging for conventional measurement methods, as it leads to disentangling and handling issues. Atomic Force Microscopy (AFM) turns out to be a powerful tool, not only for morphology studies, but also for mechanical characterization of individual fibers through force spectroscopy mode.

The present study was focused on PCL fibers produced by electrospinning and showing diameters of a few hundred nanometers. Single fibers were mechanically tested using a nanoscale three-point bending method, based on atomic force microscopy (AFM) and force spectroscopy analyses.
This method for determining mechanical properties of individual fibers is versatile and might thereafter be applied to other fiber types.

Acknowledgements:
F.C. is grateful to the Belgian « Fonds pour la Formation à la Recherche dans l'Industrie et dans l'Agriculture » (FRIA) for financial support.
This work has been supported by the Science Policy Office of the Belgian Federal Government (BELSPO - IAP 6/27).

Reference:
F. Croisier, A.S. Duwez, C. Jérôme, K.O. van der Werf, P.J. Dijkstra, M.L. Bennink, Publication in progress.