Nanobiomechanics: a tool for biomaterials mechanical properties evaluation

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ABSTRACT

Nanobiomechanics is the technology applied for the understanding of the fundamental behaviour of living cells and biomolecules. Through nanoscale investigation of mechanical properties of living cells it is assessed the mechanical interaction of cells with their surrounding structures, as well as with other cells [1]. This is considered crucial, particularly when trying to develop new tissue engineering and regenerative medicine strategies. For example, measuring nanoscale forces exerted by proteins on cells can potentially afford new understanding on various diseases, such as osteoarthritis [2], cancer and malaria due to cells elasticity and adhesion alterations.

Scaffolds are promising biomaterials for tissue regeneration and much attention has been given in the development of engineered structures that promote cells' adhesion, growth and mechanical stability. Fabrication of coatings and/or three-dimensional (3D) scaffolds with appropriate geometry, presenting nano- and micro-features are widely investigated in terms of their mechanical properties to study the substrate effect on cells growth and provide a comparison of the mechanical properties of the reconstructed tissue to the normal one.

In this study, we present the nanomechanical properties of innovative coatings and 3D ring structured scaffolds consisting of methacryloxypropyl trimethoxysilane, zirconium propoxide, and 2-(dimethylamino)ethyl methacrylate (DMAEMA) and disc samples of chitosan and poly(ε-caprolactone) copolymer. These materials have already presented appropriate cell adhesion and growth[3], rendering them suitable biomaterials for tissue engineering applications. Our aim was to investigate their nanomechanical properties and evaluate the accuracy of the obtained measured hardness and elastic modulus values through optical observations and mathematical models. From the experimental work it is indicated that each soft matter sample responded differently under applied loads, and certain experimental tests had to be performed in order to obtain the needed information and eliminate the effect of pile-ups, time dependent viscoelastic behavior. It is though understood that nanobiomechanics is the key for providing all the needed information of the deformation mechanisms of low volume, geometrically varied and inhomogeneous materials and seeding light in the potential use of biomaterials in tissue engineering.

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