Hybrid fibrous microenvironments for muscle tissue engineering

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To mimic the natural environment of tissues, in-vitro, support structures are necessary in order to allow for healthy cell and tissue development. Hydrogels have become popular materials to develop these support structures due to their substantial water content and the simplicity in tailoring their physical, biological or chemical characteristics. However, hydrogels alone cannot provide all the necessary stimuli and microenvironment for cell development and, therefore, hybrid materials are currently being developed.

Cells and tissues also require more than a suitable biochemical environment to successfully develop and differentiate [1]. Specifically, electrical and mechanical stimuli are extremely important for tissues such as skin, cartilage, bone and muscle. Scaffolds can be functionalized with nanomaterials, so they can deliver these stimuli to improve the viability of the new tissue [2].

Muscle is an electromechanical material, highly responsive to these stimuli [3], and it is known that negatively charged surfaces improve cell adhesion and proliferation and that the directional growth of the myoblast cells can be achieved by using aligned fibers [4].

Therefore, incorporating electroactive polymers in a hydrogel scaffold, and stimulating these polymers externally so that they can in turn stimulate the incorporated cells, allows for in-vitro mimicry of the normal conditions of muscle cell growth and differentiation [5].

In this context, the present work focuses on the development of electrospun electroactive polymer fibers [6], to fabricate functionalized hybrid hydrogel scaffolds for muscle tissue engineering.

Oriented and non-oriented fibers, based on polymers that are electroactive, biocompatible, biodegradable and biostable, have been processed and characterized. They were further modified with ionic liquids and magnetic particles to allow electro and mechanotransduction to be applied to the cells. This resulted in fibers with diameters between 0.5-3 µm, crystallinity between 45-60%, β-phase content around 90%, and magnetic properties suitable for use in a magnetic bioreactor, with the thermal stability of the polymer being unaffected by the inclusion of these materials.

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Figures

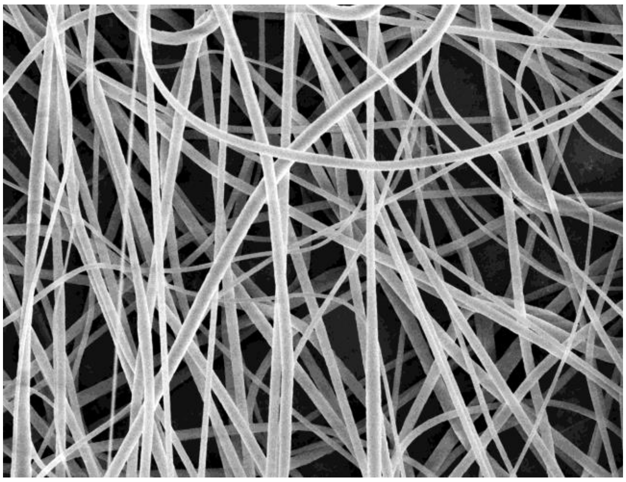

Figure 1. Non-aligned PVDF fibers

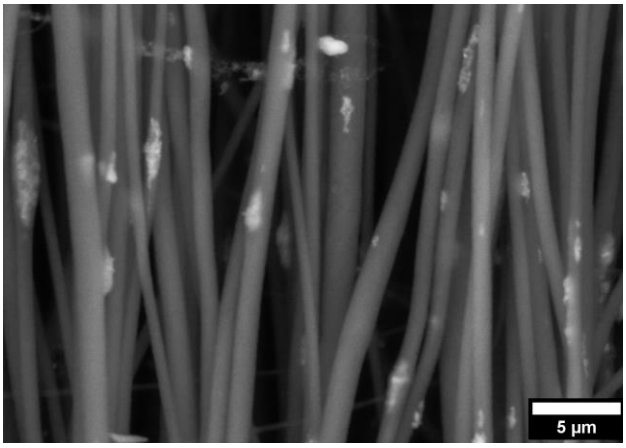

Figure 2. Aligned PVDF fibers with magnetic particles

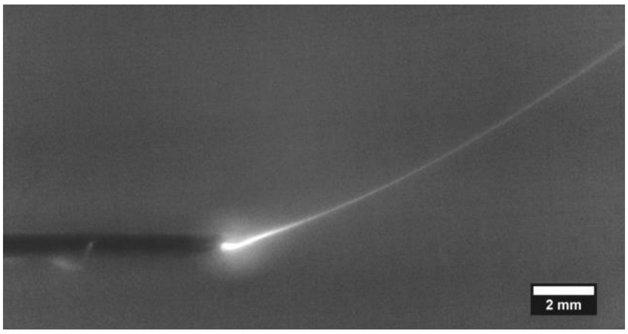

Figure 3. Photo of a fiber at the start of the electrospinning process