Effect of surface morphologies on the attachment of mesenchymal stem cells (MSCs) to electrohydrodynamic (EHD) polycaprolactone (PCL) fibers
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Though it has been known that topography provides a set of signals for cells very little quantitative examination of the reaction of cells to topography has been made. We investigated the attachment of MSCs on PCL fibers fabricated under different EHD parameters. The effects of key parameters (feed rate, voltage, and collector distance, as shown in Fig. 1) on the EHD process were investigated. We found that the collector distance played an important role in deciding not only the feasibility of collecting single fiber (by eliminating the whipping segment in Fig. 1) but also fibers’ surface morphologies. Different surface morphologies of collected fibers when collector distance was 10 mm and 5 mm were ascribed to different mechanisms. At shorter collector distance, the fiber’s diameter was primarily controlled by initial jet. At longer collector distance, the fiber’s diameter was primarily controlled by solvent evaporation. It could be validated by the different correlation between voltage and fiber diameter when collector distance was 10 mm and 5 mm (Fig. 2). MSCs exhibited better morphologies on fibers collected under 5 mm collector distance than those on fibers collected under 10 mm collector distance (Fig. 3). This phenomenon can be explained by different topographies and roughness of fibers.

In this work, fibers' topologies, roughness and diameters were determined using the 3D material confocal microscope. Cells' attachment to fibers was observed under scanning electron microscope (SEM). The combination of quantitative measurement of a 3D material confocal microscope and qualitative measurement of SEM gave a good explanation of the interaction between cells and substrate topographies at the nanometric scale, which has great importance for use in cellular engineering and tissue repair.

Fig. 1. Schematic diagram of the electrospinning process.

Fig. 2. The relationship between fiber diameter and feed rate at different collector distance.

Fig. 3. SEM images of morphologies of fibers collected when collector distance is (a) 10 mm, (b) 5 mm and cells' attachment on fibers collected when collector distance is (c) 10 mm, (d) 5 mm.

Fig. 4. Topographies images of fibers measured by a 3D material confocal microscope (scale bar 100 μm).