Modifications of polycaprolactone films crystallinity in terms of tissue engineering applications

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INTRODUCTION: Few research groups have highlighted the unexpected degree of cell proliferation depending on the degree of crystallinity of the substrate [1-3]. Commonly used methods of forming three-dimensional scaffolds do not take into account crystallinity optimisation. The aim of proposed presentation is to investigate polycaprolactone (PCL) substrate supermolecular structure effect, mainly crystallinity, on cells spreading, activity and proliferation.

METHODS: PCL M_n = 10k, M_n = 45k and M_n = 80k g/mol were used. As a solvents: HFIP (H) and Acetic Acid (AA) were used.

The first step of the methodology are experimental studies with a view to select process conditions to form polymeric foils with different degree of crystallinity. Two methods of foil preparation were analysed:

-forming from melt (PCL10, PCL45, PCL80)

-forming from solution (e.g. PH10, PH45, PAA45)

In both methods, the degree of crystallinity is modified by using different PCL molecular weight and solvents as well as annealing at different temperatures .

Degree of crystallinity was analysed using differential scanning calorimetry (DSC). Foil topography was analysed using atomic force microscopy (AFM). Selected mechanical properties and hydrophilicity (contact angle) significant from the viewpoint of cellular activity were determined. L929 cells adhesion and morphology was analysed by immunohistochemical staining for actin and nuclei at day 3. Cell activity was anlysed by MTT test.

RESULTS: Dependence of crystallinity from DSC measurements on PCL casted films from AA and HFIP solution in different concentration, using different molecular weight was analysed (Figure 1). No significant changes of crystallinity were observed for casted films PAA10 in comparison to PAA45, PAA80 in different concentration. Our modulations of solution concentration led to formation casted films with crystallinity in the range 0,51-0,68 (Fig.1). Generally, film crystallinity formed from HFIP is lower than from AA as a results of lower boiling point of HFIP. Additional annealing enables an increase of crystallinity to 0,83. Mechanical properties strongly depends on crystallinity. Films topography changes from the flat (films from the melt) to the wavy (undulate- films from the solution) which governs the contact angle. All PCL films were found as nontoxic for L929 cells (Fig.2). Differences in cells spreading, activity and proliferation degree were found.

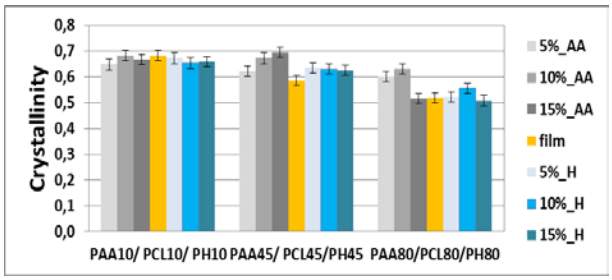

Fig. 1: Crystallinity of PH and PAA and films from the melt measured by DSC

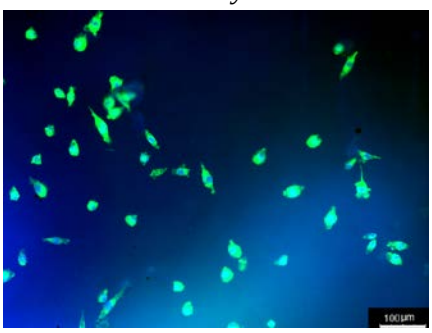

Fig. 2: L929 on PCL45

DISCUSSION&CONCLUSIONS: Modification of molecular weight, solvent and concentration of PCL enables formation of films with wide range of crystallinity. Additional annealing is an effective way of increasing crystallinity. Cells during in-vitro study interact with the substrate. Crystallinity as part of the supermolecular structure governs the cellular response.

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