Plasma treated and nano/micro-structured PEEK substrates for adipose tissue-derived stem cell studies

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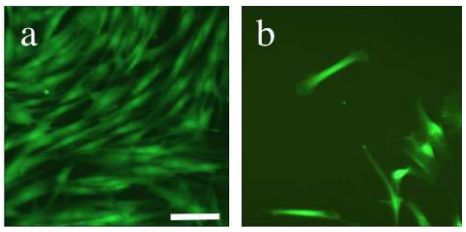
INTRODUCTION: Polyetheretherketone (PEEK) gains increasing interest as biomaterial for trauma, orthopaedic and spinal implants.[1] Since cell shape is known to regulate different-tiation of human mesenchymal stem cells[2]. Our aim is to develop surfaces that induce alterations in stem cell shape and thus a specific stem cell differentiation. By means of plasma treatment and micro-structuring we modified PEEK foils and characterized adipose tissue-derived stem cells (ASC) in direct material contact.

METHODS: APTIV PEEK foils were hot embossed from a silicon master (150°C, 100kN, structure depth 1µm). The foils were ammonia or oxygen/argon plasma treated (10 to 100 W, 5min, 30 sccm) before cell seeding (2* 10^4 cells/cm^2). ASC were isolated from lipo-suction-derived adipose tissue. Cell cultivation was under standard conditions (i.e. 37°C, 5% CO_2). Cells were cultivated 48 h on the PEEK substrates and subsequently depicted by the fluorescence staining Calcein-AM.

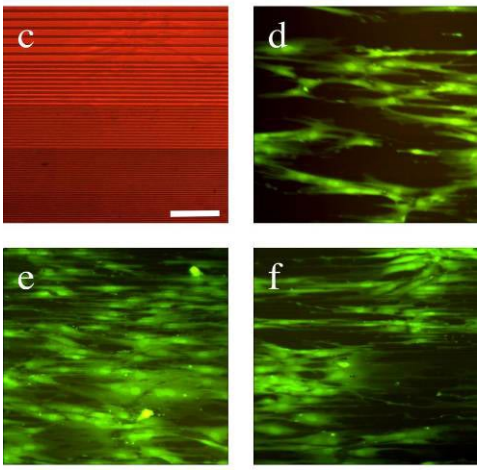
RESULTS: Plasma treatment and micro-structuring clearly influenced phenotype and proliferation of ASC. On untreated PEEK foils (fig b), the cells grew heterogeneous and at low densities compared to TCPS controls (fig a). Both oxygen and ammonia plasma treatment increased cell number, similar to TCPS controls. Interestingly, strong oxygen plasma treatment (100 W) resulted in cell aggregation rather than a dense cell layer.



ASC on a) TCPS and b) untreated PEEK. Scale bar: 100 µm.

Notably, plasma treatment induced nano-structuring on the PEEK surface. The pillar-like features increased in size (10 nm to 200 nm) with increasing intensity of the plasma treatment (10 W to 100 W).

Regarding micro-structuring by hot embossing, ASC clearly aligned on grooved substrates (fig c-f), independent of groove width (2-20 nm). Again, untreated surfaces induced heterogeneous cell spreading (fig d). Mild oxygen plasma treatment (fig e) resulted in homogenously distributed and aligned cells, whereas harsh oxygen plasma treatment (fig f) clearly showed ASC aggregation in combination with alignment.



ASC on grooved PEEK substrates (width 2-20 nm). c) empty, d) untreated, e) O_2 plasma 10 W, f) O_2 plasma 100 W. Scale bar: 100 µm.

DISCUSSION & CONCLUSIONS: Our still preliminary results demonstrated that ASC reacted to micro-structuring and plasma treatment of PEEK foils with different phenotypes. The aim is to investigate the stem cell differentiation potential of thus induced phenotypes into osteogenic and adipogenic lineage. Furthermore, we are going to analyze the nano-structuring effect of plasma treatment in more detail[3].

REFERENCES: [1] S.M. Kurtz and J.N. Devine (2007) *Biomaterials* **28**:4845-69. [2] R. McBeath et al. (2004) *Developmental Cell* **6**:483-95. [3] M.S. Lord et al. (2010) *Nano Today* **5:**66-78.

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