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Carbon nanopillars for enhanced stem cell differentiation and dopamine detection

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Introduction

Parkinson’s disease is characterized by a deficit of dopamine in the brain, a neurotransmitter involved in the motor function. One of the future ideas for treatment is cell replacement therapy. Our group has previously shown that pyrolysed 3D carbon micropillars induce spontaneous differentiation of human neural stem cells (hNSCs) into dopaminergic neurons and that they can also be employed for detecting dopamine release from mature neurons attached to them [1]. Here, we report 3D carbon nanopillars, fabricated through colloidal lithography, with even more pronounced effect on the electrochemical detection of dopamine.

Fabrication

The 3D carbon nanopillars were obtained using 1 µm polystyrene beads as etching mask and an etching time of 20 min, leading to structures with a height of 1.2 µm and a diameter of 450 nm (before pyrolysis) and a height of 600 nm and a width of 200 nm after pyrolysis.

For comparison, the micropillars we refer to have a height of 11 µm and a diameter of 1.4 µm after pyrolysis.

Stem cell differentiation

Cell line: hVM1-Bd-x(L) (human ventral mesencephalic neural stem cell line 1).

The cells were seeded and cultured on tissue culture polystyrene (TCPFS), flat carbon, micropillars and nanopillars (figures 2 and 3) in similar conditions. Differentiation was tested both in the presence and absence of differentiation factors (DF) on all surfaces.

Electrochemical measurements

The electrochemical behaviour of carbon nanopillars was investigated using cyclic voltammetry [Ru(NH3)6]3+/2+ as standard redox probe (figure 5).

Conclusions

Carbon nanopillars were fabricated using colloidal lithography/pyrolysis and employed as substrate for stem cell differentiation and dopamine detection. Detection of dopamine released from hNSCs differentiated into dopaminergic neurons is improved on the carbon nanopillars.