Increased Cell Proliferation and Metabolism by Electrical Stimulus on Nanocarbon Hybrid Platforms

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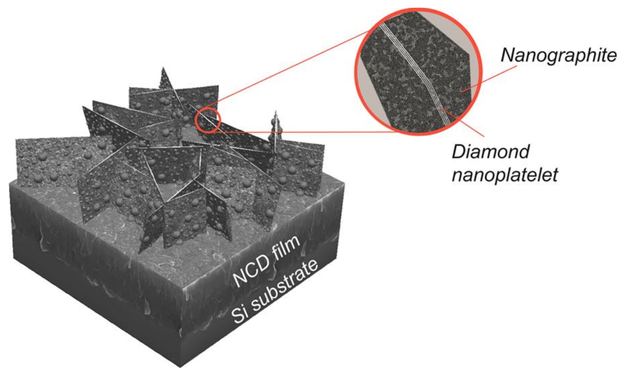
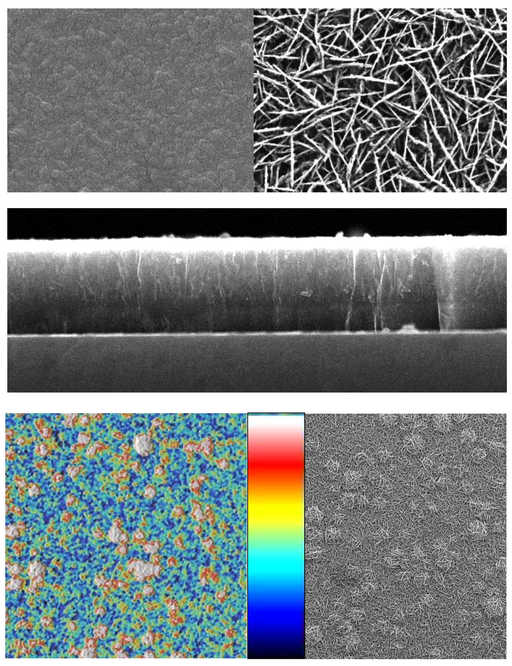
SCOPE

Nanocarbon allotropes constitute viable alternatives when designing control and actuation devices for electrically assisted tissue regeneration purposes, profiting from chemical inertness, biocompatibility, extreme mechanical properties, and, low and tailorable electrical resistivity.

In this work, coatings of thin (100 nm) vertically aligned nanoplatelets composed of diamond blades (5 nm) sandwiched in nanographite (DNPs) produced by MPCVD were used as substrates for electrical stimulation of MC3T3-E1 preosteoblasts.



MATERIALS/ELECTRICAL STIMULATION

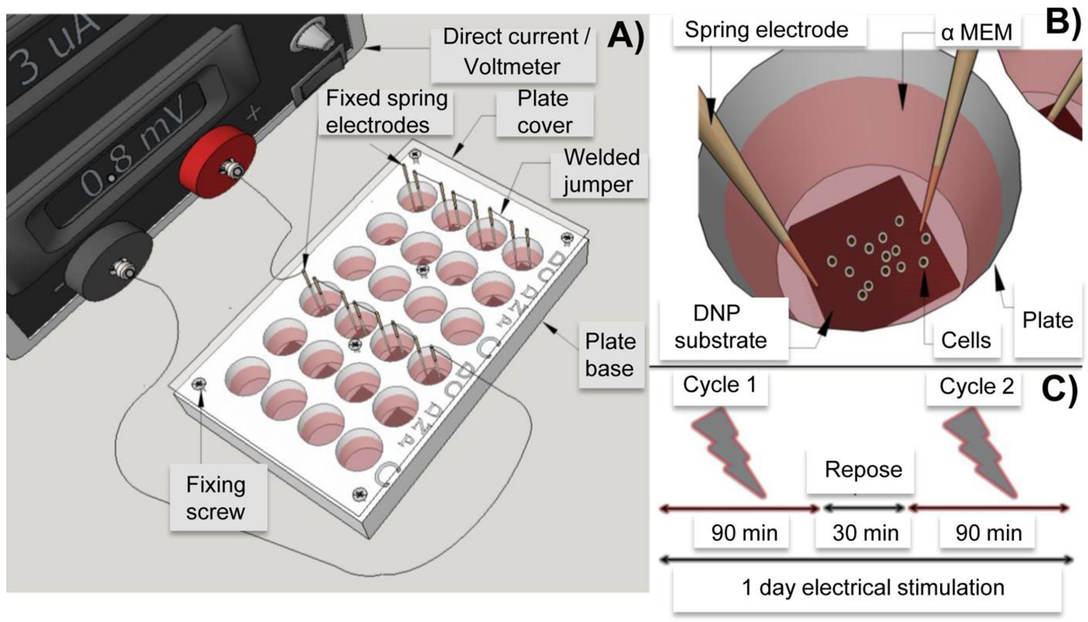


Left: SEM micrographs of nanocrystalline diamond substrate
Right: diamond-graphite nanoplatelet (DNP) grown at 14.5 vol% N_2 partial flow.

Cross section cleavage view.

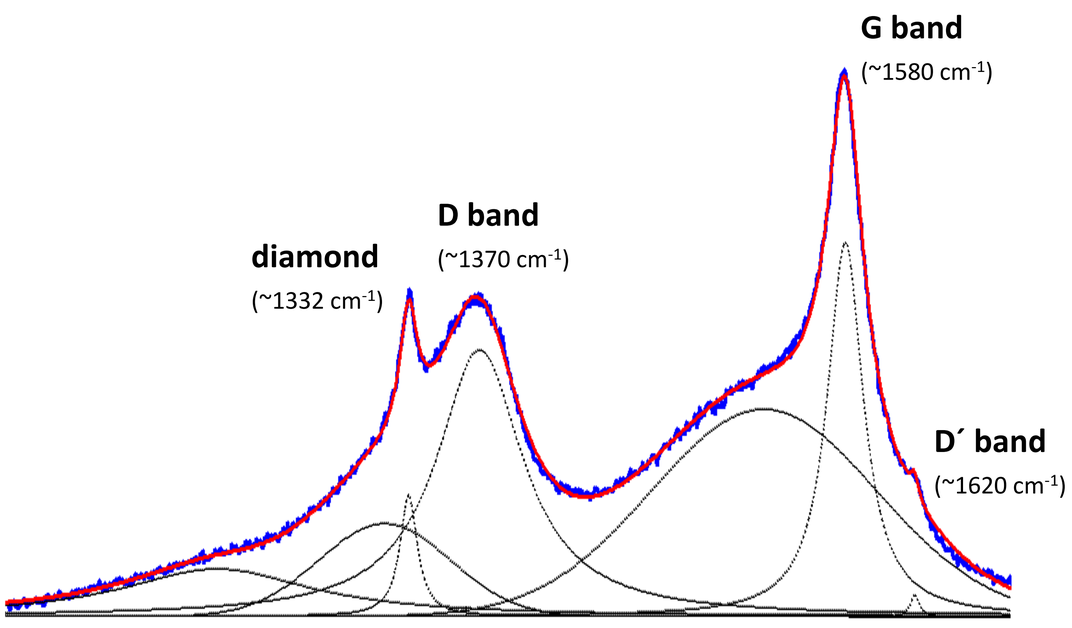
Left: high Z-resolution optical profillometry image of DNPs outermost topography.
Right: low magnification image of DNP sample.

Morphology of the multilayer material

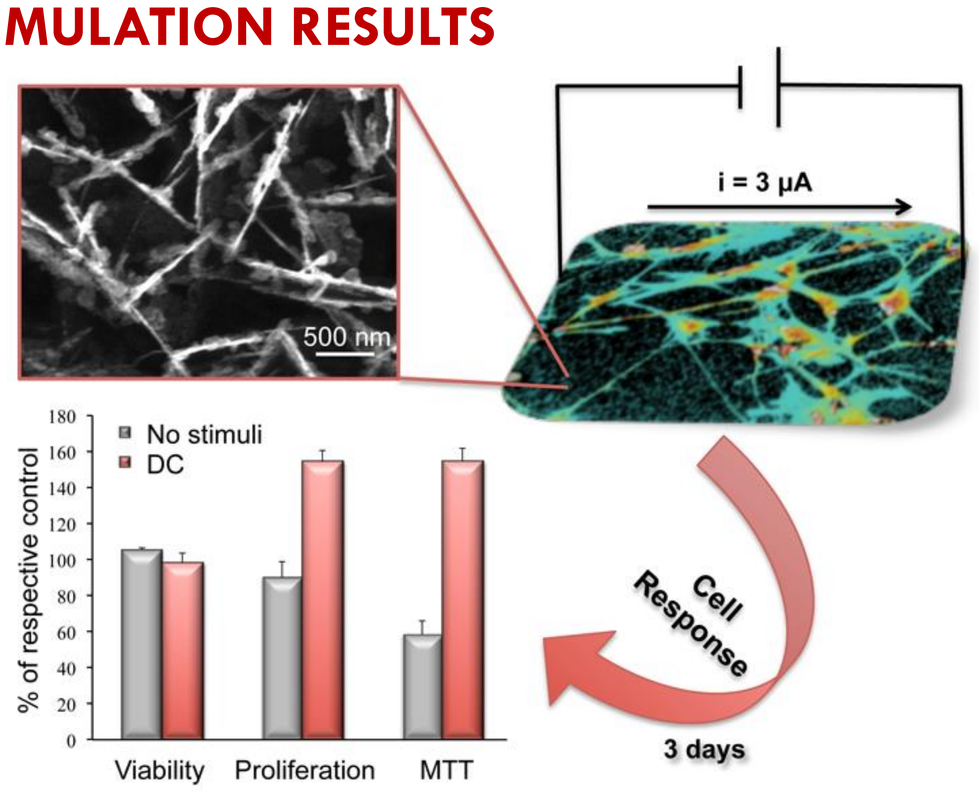


Schematic representation of the DC electrical stimulation apparatus

STRUCTURAL AND ELECTRICAL STIMULATION RESULTS



Raman spectra with band fitting of DNPs, showing the signatures of diamond and graphite (D, G and D´ bands). The other bands come from amorphous C and C-H chains.



Biocompatibility assays of MC3T3-E1 preosteoblasts after 15 days of culture.

CONCLUSIONS

- The diamond-graphite nanoplatelet (DNPs) films have proved to constitute desirable substrates for the development of biocompatible materials for electrically assisted tissue regeneration purposes.
- The addition of N_2 during the MPCVD growth was found to improve the sp^2 phase purity, to reduce the electrical resistivity and to promote vertical growth, resulting in rougher morphologies with better defined nanoplatelet structures featuring an enhanced surface area.
- DNP substrates promote the osteoblastic maturation by up-regulating local cellular processes in response to cell–material interaction. The applied electrical DC current stimulates the cell growth and metabolism of MC3T3-E1 preosteoblasts.

Bibliography

N. F. Santos, M. Cicuéndez, T. Holz, V. S. Silva, A. J. S. Fernandes, M. Vila and F. M. Costa, **ACS Appl. Mater. Interfaces** *in press* (2017)

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