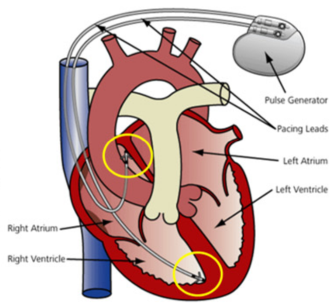
Implantable Ceramic MEMS Electrodes for Cardiac Pace-Makers

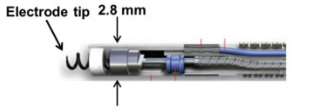
Federico Dalcanale[1,2], J. Grossenbacher[3], G. Blugan[1], M. R. Gullo[3], H. Tevaearai[4], J. Brugger[3], T. Graule[1], M. Niederberger[2], J. Kübler[1]

[1]Laboratory for High Performance Ceramics, Empa, Überlandstrasse 129, Dübendorf, Switzerland
[2]Laboratory for Multifunctional Materials, ETH Zürich, Wolfgang-Pauli-Str. 10, 8093 Zürich, Switzerland
[3] Microsystems Laboratory, EPFL, CH-1015 Lausanne, Switzerland
[4]Clinic for Cardiovascular Surgery, Inselspital Berne, Berne, Switzerland

Introduction:

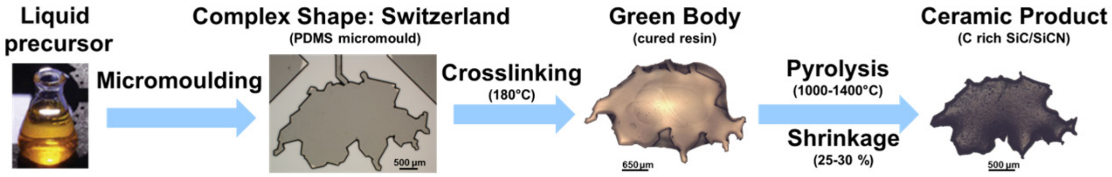
The development of new and high performance ceramics is a new trend in the medical field because their superior biocompatibility and corrosion resistance. Despite these improvements the replacement of metal with ceramics is limited because the complex shapes or the particulars properties required (e.g. electric conductivity). For these reasons, polymer derived ceramics (PDCs) technology is a valid option. Ceramics with complex shapes can be produced using polymer fabrication techniques while material properties can be tuned by precursor modification or nanofillers addition.



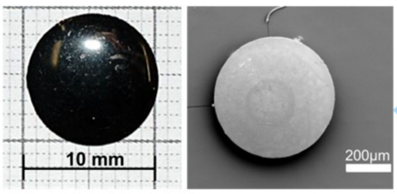


Above: Pacemaker implantation scheme.
Below: Medtronic "Sprint Quattro Secure©"
Source : Medtronic website

Electrode fabrication: PDCs technology

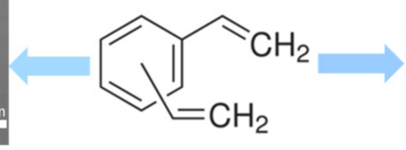


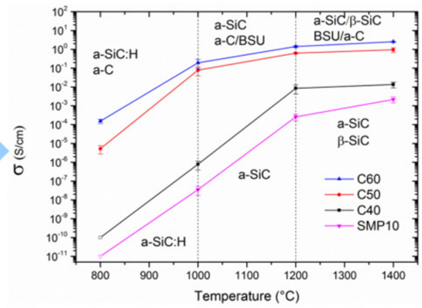
Results: effect of DVB addition to the Si-C liquid precursor

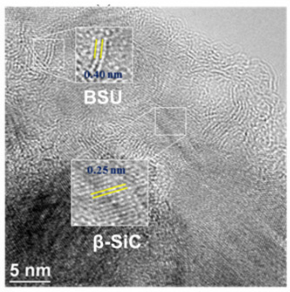


Macro and micro ceramic intact samples

DVB





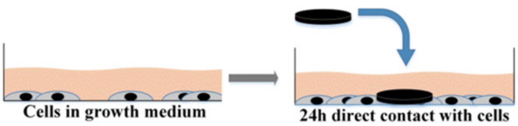


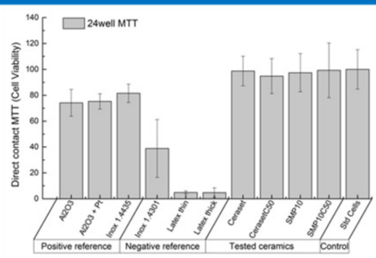
The carbon introduced remains in the microstructure as basic-structural-unit (BSU) and it improves the conductivity up to 1 S/cm

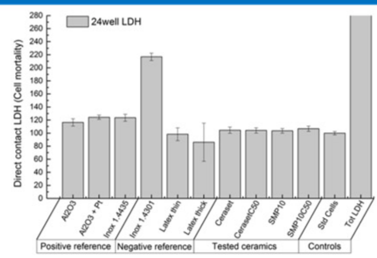
F. Dalcanale et al. Journal of the European Ceramic Society, 2014, 34, 3559-3570

Results: Biocompatibility

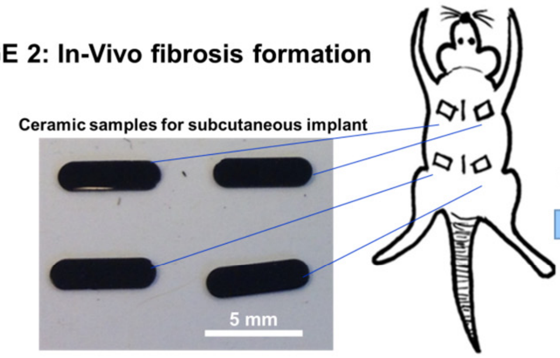
STAGE 1: In-Vitro cytotoxicity

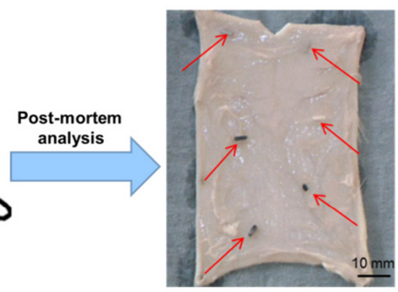


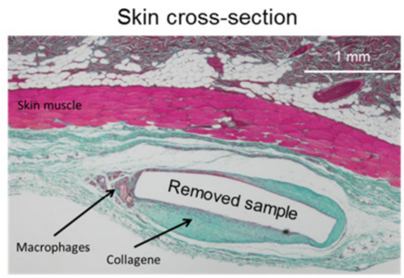




STAGE 2: In-Vivo fibrosis formation







Grossenbacher J, Dalcanale F, et al. Journal of Biomedical Materials Research Part A. 2015.

Conclusions

- **Intact microsized ceramics with conductivity up to 1 S/cm were fabricated via liquid route using PDCs technology**
- **In-vitro and In-vivo analysis of the developed ceramics show cytotoxicity and fibrosis formation similar to standards (e.g. alumina)**
- **PDCs ceramics are suitable materials for biomedical applications such as bio-electrode for pacemakers**

Contact

Federico Dalcanale dalcanaf@student.ethz.ch

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