Choice of Electrode Coatings for Low Threshold Cardiac Pacing: *In Vitro* Efficiency Study

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Introduction

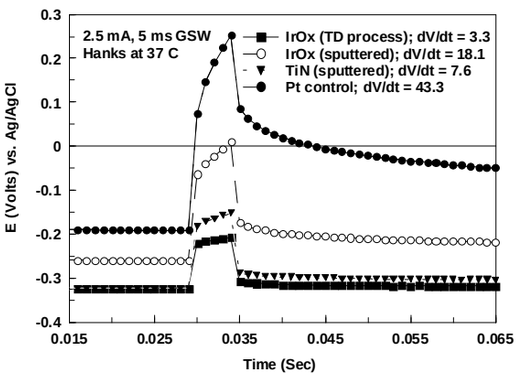
Electrode coatings intended for low threshold cardiac pacing are compared and ranked based on stability and efficiency criteria. Electrical efficiency is directly related to electrochemical processes at the coating/electrolyte interface, specifically, electrode polarization characteristics. High efficiency electrode coatings have minimal polarization loss during charge injection. The effect of coating morphology and composition on polarization was investigated.

Methods/Materials

Iridium Oxide (IrO_2) and Titanium Nitride (TiN) coatings were characterized *in vitro* by electrochemical and surface analytical techniques. Iridium oxide was prepared either by (a) thermal decomposition or (b) reactive sputtering. Titanium Nitride was reactively sputtered. The coatings were tested for their polarization behavior, capacitance and electrochemically active surface area using Cyclic Voltammetry (CV), Galvanic Square Wave (GSW) and Electrochemical Impedance Spectroscopy (EIS). Coating morphology and composition was characterized with SEM/EDX and XPS/AES. The electrochemical experiments were conducted either in Hanks or Phosphate Buffered Saline (PBS) solution at 37 ^{o}C. Coating morphology and composition was characterized with SEM/EDX and XPS/AES (X-ray Photoelectron Spectroscopy and Auger Electron Spectroscopy). Stability, which is a decisive factor in the choice of electrode coating, was assessed by galvanostatic test. The performance of the coated electrodes was compared to a smooth uncoated Pt control electrode of identical geometric surface area and shape.

Results

The coating polarization behaviors, measured by a 2.5 mA, 5 ms GSW, are compared below:



Conclusion

The IrO_2 coatings, prepared by a thermal decomposition process, exhibited the lowest electrode polarization. The thermally deposited Iridium Oxide also had the roughest morphology, highest electrochemically active area and largest capacitance. The reactively sputtered IrO_2 with smooth featureless morphology exhibited higher polarization than reactively sputtered TiN, with micro-porous surface texture. When compared to the smooth uncoated Pt control, all the coatings show considerably lower polarization.

References:

1. (a) C. Angelinetta, S. Trasatti, L. Atanasoska, R.T. Atanasoski and Z. Minevski, *Mater. Chem. Phys*., **22**, 231-247, 1989; (b) L. Atanasoska, R.T. Atanasoski and S. Trasatti, *Vacuum*, **40**, 91-94, 1990