Bioheat Dissipation of a Implantable Brain-Machine Interface

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Abstract

Brain-Machine Interfaces (BMI) provide a direct communication link between brain and external devices such as speech synthesizers and robotic prosthesis to restore speech and movement in persons affected by Spinal Cord Injuries or neurodegenerative diseases such as Amyotrophic Lateral Sclerosis (ALS).
The best results of movement restoration with BMIs are achieved with high-resolution Multi Electrode Arrays (MEA) implanted in the brain's motor cortex. One example of such implantable BMI is the BrainGate device tested few years ago in US that consisted of a MEA connected via a percutaneous connector to an external computer. To reduce the risk of infection associated with percutaneous connectors, Wyss Center for Bio and Neuroengineering has been working in collaboration with the team of BrainGate to create a human grade wireless BMI.
One of the major challenges of this implantable device is dissipating the heat generated in the titanium can by eddy currents during wireless power transfer to recharge its internal battery. Therefore, an upper limit of heat dissipation in human tissues was calculated with COMSOL Multiphysics® Heat Transfer Module to meet standard ISO 14708-1:2014 that requires that no external surface of Active Implantable Medical Devices rise more than 2°C above body temperature of 37°C.