In Vitro Biocompatibility of Dual-Band TiN Antenna in Excited and Non-Excited Environments in Real Time

Madeline Hays*[(1)(2)], Lynn E. Secondo [(3)], Ryan Green[(2)], Nastassja Lewinski[(3)], and Erdem Topsakal[(2)]
(1) Department of Biomedical Engineering, Virginia Commonwealth University, Richmond, Virginia USA
(2) Department of Electrical and Computer Engineering, Virginia Commonwealth University, Richmond, Virginia, USA
(3) Department of Chemical and Life Science Engineering, Virginia Commonwealth University, Richmond, Virginia, USA

Since 2012, increased life expectancy and obesity have exacerbated the level of chronic disease to over half of the US adult population according to the Centers for Disease Control and Prevention. As a result, the demand for technology to monitor and prevent chronic diseases has intensified, while simultaneously introducing new demands to connect physicians to patients directly.

Fully implantable biosensor-telemetry systems offer an eloquent solution by monitoring disease progress through analytes while automatically communicating pertinent information to doctors. For communication via antennas, titanium nitride (TiN) is a promising material due to its biocompatible nature. For instance, TiN antennas do not require additional silicone layers for implantation—allowing for miniaturization and lower power requirements for data transmission. Power requirements are critical in any implantable system as radiofrequency (RF) transmission increases the thermal energy of surrounding tissue defined by the specific absorption rate (SAR). However, even with federal regulations in place, little is known about cellular reactions to direct RF exposure at various power levels. Assessing cell-to-antenna interactions will provide greater understanding of RF effects on tissue and the human body as a whole.

In this study, we seeded TiN antennas with mouse L929 cells, a standard for *in vitro* measurements. After an initial 24-hour growing period, cells were prepared for measurements of cellular viability through toxicity and oxidative stress. Following staining, antennas are placed in an environmental chamber maintaining 37°C and 5% CO_2 for imaging. Assays were applied to three experimental groups: (1) non-excited control group (2) 0 dBm output power excited group and (3) 15dBm output power excited group. Over the span of 4 hours, optical images and fluorescent images are taken at regular intervals to measure effects of increased thermal energy on cell health in real time. Fluorescent images measured cell viability through nuclei and plasma staining and oxidative stress through the generation of reactive oxygen species. Additional non-fluorescent tests performed include cytotoxicity measurements through dead cell staining, lactate cellular membrane damage, and cell proliferation. The combination of results for these assays paints an image of cell health when exposed directly to powered wireless telemetry.