High Gain Implantable Dual-Band Patch Antenna

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Implantable antennas are an area of interest due to their prevalence in emerging medical technologies, such as energy harvesting and wireless medical sensing. In this work, we introduce a novel dual-band implantable antenna that is designed to operate at 2.4 GHz and 4.8 GHz while occupying a miniature footprint of 15 mm × 10 mm. Our preliminary results demonstrate a higher average realized gain between both bands of the proposed antenna compared to previously reported designs. Specifically, the proposed antenna is a modified E-shaped patch that includes slots along the microstrip feed to allow for improved coupling between the feed and the antenna itself. Having two frequencies allows for an implanted system to use the same antenna for distinct transmit and receive signals. For antenna miniaturization, a high-permittivity Rogers TMM13i (ε_r=12.2 and tanδ=0.0019) substrate is used. Moreover, a low-loss polymer layer (polydimethylsiloxane, PDMS, ε_r=2.8 and tanδ=0.001) is used to coat the antenna and ensure biocompatibility. This polymer layer also serves to improve antenna efficiency and help with meeting Federal Communications Commission Specific Absorption Rate (SAR) standards (F. Merli, et al., IEEE Trans. Antennas Propag., 59, 21–31, 2011). In our simulation, human-tissue-emulating material was employed around the antenna to allow for realistic modeling of the associated losses. The antenna's design parameters were optimized for the lowest reflection coefficient at both bands using an in-house genetic algorithm. Notably, the high gain of the proposed implantable antenna is anticipated to enable: a) more effective communication with exterior monitoring/control units, b) deeper implantation depths per the application requirements, and/or c) lower power levels needed for communication. In turn, these advancements are anticipated to increase the efficiency of implanted energy harvesters and provide more accessibility for wireless medical implants. At the conference, we will show measurement results for the proposed antenna inside tissue-emulating phantoms, highlighting its superior performance compared to existing designs.