Title: Fully Self-Healing UHF RFID Tag Based on a Slot Antenna for Future Skin-Like Electronics

Authors:

Nikta Pournoori[(1)], Toni Björninen[(2)], Jarkko Tolvanen[(3)], Jari Hannu[(3)], Lauri Sydänheimo[(1)], Jari Juuti[(3)], and Leena Ukkonen[(1)]

[(1)] Faculty of Medicine and Health Technology, Tampere University, Finland, {nikta.pournoori, lauri.sydanheimo, leena.ukkonen}@tuni.fi
[(2)] Faculty of Information Technology and Communication Sciences, Tampere University, Finland, toni.bjorninen@tuni.fi
[(3)] Faculty of Information Technology and Electrical Engineering, University of Oulu, Finland, {jarkko.tolvanen, jari.hannu, jari.juuti}@oulu.fi

Keywords:

Passive UHF RFID tag, read range, self-healing material, self-healing UHF RFID tag antenna, wireless sensor

Abstract

Self-healing functional polymers, blends, and composites provide a promising approach for fully soft, elastic electronics and wireless sensing technologies. The autonomous self-healing material functionality to be created in this project works like human skin or tissue regeneration. The healing process takes minutes or hours, depending on the polymer's properties, and is significantly faster than human skin healing. This material and fabrication methods enable new, robust, sustainable, and resilient electronics and wireless sensing systems. The self-healing material concept not only introduces advanced functionalities but also extends the operational lifespan of wireless devices under extreme conditions, such as cold, saline, pressurized, or even space environments. These innovations can be achieved without compromising the user experience or the functional requirements of the wireless systems. Our new self-healing UHF RFID-based wireless sensor can even be re-moldable and attachable to new objects after initial use, enhancing its versatility for diverse applications from healthcare and robotics to consumer electronics and beyond.

In this work, for the first time, we study through numerical simulations the feasibility of utilizing such materials to design a fully self-healing antenna for a passive UHF RFID tag. A challenge for the tag's performance is that currently, a conductivity of up to ~150 S/m has been achieved, whereas the conductivity of copper conductors is approximately 60 MS/m. However, our simulation results demonstrate that a functioning passive UHF RFID tag with a read range of more than two meters can be achieved with a slot antenna made of the multiphase PEDOT:PSS conductor.