A Wireless, Passive Strain Sensor: Application to *In Vivo* Monitoring of Compressive Forces at Knee Implants

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This study describes the design of a new wireless and passive sensor for *in vivo* strain monitoring at knee replacements. In a total knee arthroplasty, the proximal end of the tibia and the two femoral condyles are replaced with artificial components, and a high-density polyethylene insert is placed between the two components. The wear and tear of the polyethylene insert is considered a threat to the long-term survival of many knee implants. We have designed a wireless, implantable strain sensor to study the stresses experienced by the polyethylene insert. The sensor, which is embedded within the insert, is comprised of a magnetically soft material (sensing element) and a magnetically hard material (biasing element) separated by a deformable/flexible layer. Under AC magnetic field, the sensing element generates a secondary, higher-order mode magnetic flux that can be measured with a magnetic inductive coil. Additional stresses to the sensor deform the flexible layer, altering the higher-order magnetic flux and thus allowing remote measurement of compressive forces. The advantages of this sensor are, its wireless and passive nature, small size, and cost effectiveness. The remote query nature of this sensor allows long-term implantation and real-time monitoring of human body. Experimental results have shown that the sensor responded linearly with applied stress and demonstrated good repeatability and stability. We believe that the outcome of this project will greatly improve public health by leading to a better implant design and providing a convenient way to detect wear and tear of knee implants.

