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Abstract

Individualised additive pickup coils

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Additively printed electrical sensors offer the possibility to create customised or flexible sensor solutions with a higher degree of freedom in the design. This abstract presents an additively fabricated sensor for measuring alternating fields, applied here in the context of magnetic particle imaging (MPI). MPI is a preclinical medical imaging technique with great potential for non-invasive, high-resolution imaging applications. MPI is based on the detection of nanoparticles, that act as tracers within the body, providing excellent contrast and sensitivity for visualising biological functions. To generate the signal response, the nanoparticles are exposed to alternating magnetic fields at various frequencies typically at around 25 kHz and emit higher harmonic frequencies due to their nonlinear magnetisation behaviour. Based on this signal response, the spatial concentration of the nanoparticles can be reconstructed into grey scale images [1,2]. For calibration of MPI devices there is a need for precise and efficient magnetic field sensors. Measuring an alternating magnetic field typically involves using specialised instruments designed to detect and quantify magnetic fields that change in strength or direction over time. This work is focused on developing a pick-up coil for detecting high alternating fields up to several MHz [2,3]. During construction of a pickup coil, adjustments can be made to the resulting induced voltage by varying the number of windings and the induction cross-sectional area. After construction, the coil needs to be wound, a process typically done by hand or winding machines. However, winding tiny structures and wires by hand or machine can be challenging, resulting in coils with poor accuracy that may not match the precision achieved during the initial construction. Additive manufacturing offers a significant advantage in producing coils autonomously, with a high degree of freedom, greater accuracy and consistency, leading to improved overall performance and reliability. These designs include complex nested structures of several coils needed for multi-directional sensors. As exemplary application a two directional sensor was developed using computer aided design (CAD) and printed by the Dragonfly IV from Nano Dimension. During the print conductive and dielectric ink from Nano Dimension was used. The produced sensor has a squared outer dimension of 6.8 mm and consists of three windings while enclosing an area of 17.29 mm² in x-direction and three windings enclosing an area of 6.29 mm² in y-direction. To achieve measurements in a MPI scanner the coil was mounted to a glass fibre rod and soldered to an SMA connector. Afterwards the field of a preclinical MPI setup was measured. A one-dimensional hand-wound coil was constructed and produced for comparison. However, replicating the additively manufactured coil proved unfeasible due to stability constraints and nested topology. The presented way of fabricating magnetic field sensors offers not only high precision and reproducible results, but also a way to fabricate sensors with minimal human interaction and resources.

AUTHOR'S STATEMENT

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