Transactions on Additive Manufacturing Meets Medicine
Trans. AMMM, Vol. 4, No 1, Suppl. 1, Article ID 672, 1 Page

Infinite Science Publishing

Abstract

Field Generator for INSPECT with optimized Cooling

N. K. Menon[1], A. Malhotra[1,2*], and K. Lüdtke-Buzug[1,2]

[1] *Institute of Medical Engineering, University of Lübeck, Lübeck, Germany*
[2] *Fraunhofer Research Institution for Individualized and Cell-Based Medical Engineering IMTE, Lübeck, Germany*
[*] *Corresponding author, email: ankit.malhotra@imte.fraunhofer.de*

Additive manufacturing has proved to be an excellent methodology for rapid prototyping of required components used in scientific setups. In the past few years, there has been an immense improvement in the physical properties of the printing material making it possible to have high thermal resistivity with required tensile strength.

In this research, the focus is on the design and development of the field generator housing for INSPECT (In-situ magnetic particle spectrometer) [1]. The field generator for INSPECT consists of a transmit coil and a gradiometer coil. The transmit coil is responsible for generating the field required to excite the magnetic nanoparticles. The gradiometer coil contains two different coils: the cancellation coil and the receive coil for acquiring the response of the magnetic particles and separating it from the excitation signal. The field generator of INSPECT is designed to monitor the real-time nucleation and growth of SPIONs, therefore must withstand a change in temperature depending upon the synthesis process.

The housing for the field generator is designed using SolidWorks 2020 from Dassault Systèmes in France and 3D printed using Form 3B from Formlabs Inc. in the USA. The material used for printing is a High-Temp Resin from Formlabs Inc., with a heat deflection temperature (HDT) of 238 °C at 0.45 MPa [2]. To prevent excessive heating of the transmit coil, the housing contains small cooling-channels which allow air to across the surface of the coil. Additionally, the housing also accommodates Polyethylene tubes which are placed concentrically around the transmit coil.

Coolant can be passed through these tubes to achieve additional cooling of the transmit coil using a feedback loop depending on the synthesis temperature. Furthermore, the field generator is insulated with the help of an 8 mm nonporous aerogel insulation for thermal resistivity against synthesis temperature [3]. Therefore, the housing offers a versatile solution in terms of keeping the coil temperature in check irrespective of the external temperature conditions arising due to magnetic nanoparticle synthesis. The high complexity of the housing makes use of the potential of additive manufacturing and would not be possible by conventional means.

AUTHOR'S STATEMENT

Conflict of interest: Authors state no conflict of interest. Informed consent: Informed consent has been obtained from all individuals included in this study. Research funding: The authors acknowledge funding by ERDF Project: "Diagnose- und Therapieverfahren für die Individualisierte Medizintechnik (IMTE)", Grant No.: 124 20 002.

REFERENCES

[1] A. Malhotra et. al., "Tracking the Growth of Superparamagnetic Nanoparticles with an In-Situ Magnetic Particle Spectrometer (INSPECT)", Scientific Reports, 2019. Doi: 10.1038/s41598-019-46882-6.
[2] Formlabs Inc., "High-Temp material datasheet", Rev 02 12.05.2018.
[3] M.A. Aegerter, N. Leventis, M. M. Koebel, "Aerogels Handbook", Springer publishing, 2011. ISBN 978-1-4419-7477-8.

DOI: 10.18416/AMMM.2022.2209672