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New, scalable, reproducible method to make high-sensitivity optomechanical magnetometers

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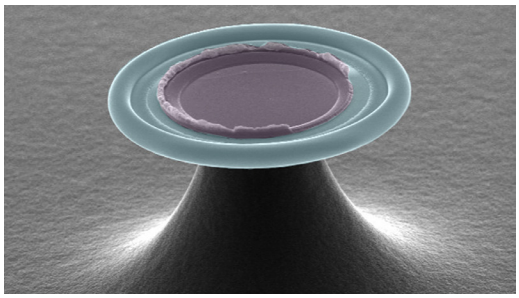
Sputter coating a magnetostrictive film onto a microcavity fabricates high-sensitivity optomechanical magnetometers without degrading optical quality factor or magnetostrictive performance.



Magnetometers measure magnetic fields with high sensitivity in various applications, including magnetic resonance imaging, magnetic anomaly detection, mineral exploration, and magnetoencephalography. Cavity optomechanical magnetometers are advantageous over other types of magnetometers because of their small size and weight, low power consumption and high sensitivity, as well as the ease of on-chip integration.

Previous working prototypes of cavity optomechanical magnetometers were made by manually epoxy-bonding magnetostrictive materials on top of or inside a microcavity. This fabrication method requires precise positioning of the magnetostrictive micro-sized grains relative to the microcavity, which makes it difficult to scale to devices of different sizes.

Li et al. developed a new fabrication method to make cavity optomechanical magnetometers. The authors sputter-coated a magnetostrictive film of Terfenol-D onto a high-quality microcavity, functionalizing the microcavity without degrading its optical quality factor or magnetostrictive performance, such that the resulting magnetometer should have a peak sensitivity comparable to those made using the epoxy-bonding technique. In addition, the authors showed that by thermally annealing the sputter-coated film of Terfenol-D, they can further increase the magnetometer sensitivity by a factor of 6.3.

The researchers claim that their technique is the first that allows a scalable and easily replicable fabrication of cavity optomechanical magnetometers on a silicon chip. Author Beibei Li said that this technique opens up possibilities for a range of applications of high-sensitivity cavity optomechanical magnetometers, such as on-chip microfluidic nuclear magnetic resonance, magnetoencephalography and geological survey.

Next, the authors plan to optimize the sensitivity by modifying the sputter coating process, and to test their sputter coating method on other magnetostrictive materials such as galfenol and metglass.

Source: "Invited Article: Scalable high-sensitivity optomechanical magnetometers on a chip," by Bei-Bei Li, Douglas Bulla, Varun Prakash, Stefan Forstner, Ali Dehghan-Manshadi, Halina Rubinsztein-Dunlop, Scott Foster, and Warwick P. Bowen, *APL Photonics* (2018). The article can be accessed at https://doi.org/10.1063/1.5055029.

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