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Microfabricated Alkali Metal Vapor Cells Based on Ultrafast Laser Welding

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The miniaturization of optical pumping magnetometer became the focus of research, and the miniaturization of the alkali metal vapor cell is the key to the miniaturization of the atomic magnetometer. The development of micro-electromechanical systems (MEMS) provides the basis for miniaturization of alkali metal vapor cells. The sealing of MEMS vapor cells was mainly realized by anodic bonding, however, the high bonding temperature as well as the high-voltage in the anodic bonding process would adversely affect the fabrication of MEMS vapor cells. In this study, a method for the fabrication of MEMS alkali metal vapor cell based on ultrafast laser welding was proposed. The fabrication of the silicon cavities was realized by dry etching and chemical polishing, following which the bonding of the silicon and glass plates was realized by ultrafast laser welding. After that, the injection of alkali metal and the buffer gas were accomplished in the constructed welding system, and finally the sealing of the MEMS vapor cell was also achieved by ultrafast laser welding. The vapor cell was heated under vacuum at 150 °C for 15 days and the absorption spectra were tested. The results showed that the leakage rate of the vapor cell with He was about 7.4×10^{-10} Pa·m³/s, which was comparable to the anodic bonding leakage rate. In addition, the small heat affected zone of ultrafast laser welding provides a new approach for the fabrication of integrated anti-relaxation coated MEMS vapor cells, which is the focus for our further work.

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