首次将微纳光纤传感器应用于光声成像

DOI: 10.12086/oee.2023.231002.h01

超声传感器作为光声成像系统的关键器件，直接决定着系统的成像性能。这种传感器的灵敏度与压电元件的尺寸成正相关，为了实现足够的灵敏度，通常需要毫米量级的压电元件，这限制了器件的小型化。

华中科技大学光学与电子信息学院孙琪真教授团队提出了利用微纳光纤大倏逝场对外界环境敏感的特性，通过对微纳光纤传感器进行优化设计，实现了高灵敏的超声检测，并首次将微纳光纤传感器应用于光声成像。

研究人员首先优化微纳光纤直径至 7 μm，并采用高弹光系数的聚二甲基硅氧烷进行封装，提高其对超声波探测的灵敏度。通过构建 Mach-Zehnder 干涉仪解调光相位的变化，并采用反馈稳定技术补偿相干系统的低频漂移，实现对超声场的高灵敏感知。实验结果表明，微纳光纤线型超声传感器的灵敏度相比于普通光纤提升了一个数量级，-10 dB 的响应带宽达到 14 MHz，噪声等效声压达到 153 Pa。同时，他们指出传感器的灵敏度和噪声等效声压可以通过优化光纤和检测系统进一步提高，以满足超弱信号的检测需求。

Opto-Electronic Advances, 2022, **5**(6): 200076.
http://www.oejournal.org/article/doi/10.29026/oea.2022.200076.

Miniaturized highly sensitive ultrasound sensor for photoacoustic imaging

DOI: 10.12086/oee.2023.231002.h01

As the key element of photoacoustic imaging system, ultrasound sensors directly decide the imaging performance. To achieve sufficient sensitivity, millimeter scale piezoelectric elements are required, which limits the miniaturization of the device.

The research group of Prof. Qizhen Sun from Huazhong University of Science and Technology proposed a miniaturized microfiber ultrasound sensor. Highly sensitive ultrasound detection was demonstrated using microfiber with large evanescent field and environmental sensitivity. Further, the photoacoustic imaging system based on the microfiber sensor was firstly realized, to the best of our knowledge.

Researchers optimized the dimeter of microfiber to 7 μm in view of the larger evanescent field. A Mach-Zehnder interferometer is constructed to demodulate the phase changes of the interrogation laser induced by the incident ultrasound waves. The sensor exhibits a low noise equivalent pressure of 153 Pa and a broad response bandwidth up to 14 MHz (−10 dB). In addition, the sensor can be used for the detection of weaker signals, by optimizing the microfiber and detection system to improve the sensitivity and bandwidth of the sensor.

The research group also demonstrated a photoacoustic imaging system based on the microfiber sensor. The performance of the imaging system is evaluated by imaging three human hairs. The signal-to-noise ratio (SNR) of the system could reach 31 dB even at the depth of 12 mm. The axial and lateral resolutions are 65 μm and 250 μm at 5 mm depth, respectively.

Opto-Electronic Advances, 2022, **5**(6): 200076.
http://www.oejournal.org/article/doi/10.29026/oea.2022.200076.