Optical System Design of Laser-Based Stethoscope

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The most commonly used stethoscopes in clinics nowadays are the acoustic stethoscopes. They operate on the transmission of sound from the chest piece, via air-filled hollow tubes, to the ears of the healthcare worker. However, even for very experienced healthcare workers, the accuracy of diagnosis of heart murmurs with acoustic stethoscope is limited by the poor ability of the human ears to low frequency heart sounds. This is important, as valuable information from subaudio sounds is present at frequencies below the human hearing range. Thus, the follow-up in-depth tests are needed in order to further distinguish different types of hear murmurs. In this paper, we report the development of a new type of stethoscope using laser technology to make the heartbeat signal "visible." In this laser-based-stethoscope, the heartbeat signal is correlated with the optical spot from a laser beam reflected from the vibrating diaphragm attached to the patient's chest skin. Vibration of the diaphragm is generated by the acoustic pressure from the heartbeat. The heartbeat signal is recorded from the movement of optical spot in time domain and it will be transformed to frequency domain to reveal more details on the heartbeat problems. Optical signal processing techniques will be applied to classify and analyze different types of heart murmurs from the visualized heart-sound patterns. This laser-based stethoscope will be helpful in reducing errors in heart-sound classification by practitioners. Additionally, the visual aspect of this stethoscope will provide subaudio (below the human hearing range) and images of sounds to the practitioner. The research results could provide better diagnosis of heart diseases and reduce unnecessary referrals. In the initial demonstration of the system presented in this paper, we set up the prototype of the optical system, in which we use a heart-sound box to simulate the chest of a human being. The movement of optical spot is detected by a linear position sensor and recorded by the USB data acquisition (DA) system. The heart-sound waves collected using iStethoscope Pro (the iPhone App) are applied to activate the vibration of the heart-sound box. With the optical system setup, we successfully acquired the visual display of the heartbeat signal in time domain based on the movement of the reflection spot from the laser beam.

Patterning PLA Packaging Films for Implantable Medical Devices

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Microhot-embossing is a less complex and inexpensive alternative over standard photolithography for patterning poly(lactic acid) (PLA) films. However, direct patterning of discrete or through-thickness microstructures by conventional microhot-embossing is not possible due to embossing-caused residual film. Use of complex modifications in the embossing process can further prohibit its integration with other standard semiconductor fabrication processes. Plasma-based reactive ion etching (RIE) of embossing-caused PLA residual film can be a viable option potentially allowing integration of the conventional hot-embossing process with standard semiconductor fabrication processes. RIE etch-rates of PLA packaging films, hot-embossed with parylene-based thin-film cochlear implant-shaped stiffener structures, were characterized for oxygen (O_2), nitrogen (N_2), and argon (Ar) plasmas under two different process conditions. The etch-rates of PLA films for O_2, N_2, and Ar plasmas were 0.29–0.72 μm/min, 0.09–0.14 μm/min, and 0.11–0.15 μm/min, respectively. Complete removal of embossing-caused residual film has been demonstrated utilizing the etching results for O_2 plasma. Also, the effect of RIE etching on resultant PLA film surface roughness has been quantified for the three plasmas.

