

Nanocomposite-Based Energy Converters for Long-Range Focused Ultrasound Treatment

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A nanostructure composite is a highly suitable substance for photoacoustic ultrasound generation. This allows an input laser beam (typically, nanosecond pulse duration) to be efficiently converted to an ultrasonic output with tens-of-MHz frequency. This type of energy converter has been demonstrated by using a carbon nanotube (CNT)-polydimethylsiloxane (PDMS) composite film that exhibit high optical absorption, rapid heat transition, and mechanical durability, all of which are necessary properties for high-amplitude ultrasound generation. In order to develop the CNT-PDMS composite film, a high-temperature chemical vapor deposition (HTCVD) method has been commonly used so far to grow CNT and then produce a CNT-PDMS composite structure. Here, instead of the complex HTCVD, we use a mixed solution of hydrophobic multi-walled CNT and dimethylformamid (DMF) and fabricate a solution-processed CNT-PDMS composite film over a spherically concave substrate, i.e. a focal energy converter. As the solution process can be applied over a large area, we could easily fabricate the focal transmitter that focuses the photoacoustic output at the moment of generation from the CNT-PDMS composite layer. With this method, we developed photoacoustic energy converters with a large diameter (>25 mm) and a long focal length (several cm). The lens performance was characterized in terms of output pressure amplitude for an incident pulsed laser energy and focal spot dimension in both lateral and axial. Due to the long focal length, we expect that the new lens can be applied for long-range ultrasonic treatment, e.g. biomedical therapy.

Keywords: Photoacoustic energy conversion, photoacoustic lens, CNT-PDMS composite transmitter

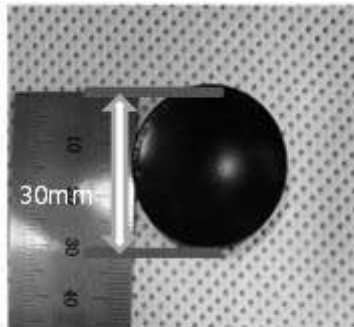


Figure 1. Fabricated CNT-PDMS composite plane-concave lens. (Diameter 30mm, Focal distance 25.95mm)

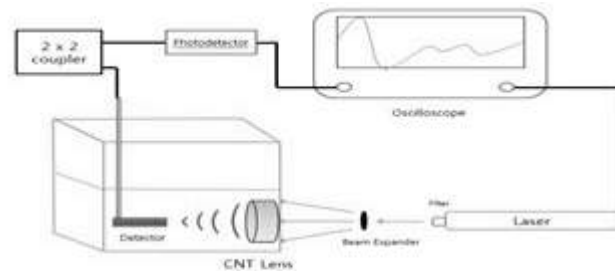


Figure 1. Experimental set up for measurement of CNT-PDMS composite lens.

plane-concave lens. (Diameter 30mm, Focal distance 25.95mm)