



## Special Feature: Nano Structured Devices

### Overview

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Access to nanoscale structures can exhibit intriguing electromagnetic-wave phenomena. Significant progress has been made in the research of “manipulating electromagnetic waves in artificial materials” for the past two decades. Exploring both physics in wave phenomena and fabrication processes of nanostructures for large area is of great importance for realizing functional electromagnetic-devices and smart systems. Toyota Central R&D Labs., Inc. has been pursuing this research since 2004, and here we report four recent works.

The first article presents a light-focusing lens having a one-wavelength thickness, which is indeed ultra-thin compared to conventional bulky lenses. The ultra-thin lens has been obtained through the full-coverage of transmission phase around a guided resonance in a periodic structure. In the second article, vibration of a carbon nanotube enables phase detection in nanoscale, as a fundamental building-block functionality for future sensing and communication via ultra-small devices. In the third article, such carbon nanotube vibration can exhibit the functionality of a phase shifter, leading to an angular sensing system. Lastly, in the fourth article, a self-assemble technique, where a desired structure can be autonomously organized, is demonstrated with SiO<sub>2</sub> spheres and nanopillars, revealing a promising bottom-up fabrication approach of nanostructures for large-scale electromagnetic-devices.