Planar-type Si thermoelectric generators using nanopatterning

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Energy harvesting is one of the key technologies for the IoT society. Energy harvesters can be used to drive sensor nodes to send physical information to the cyber space. In this presentation, planar-type Si thermoelectric generators (TEGs) with nanostructures will be picked up as an example of energy harvesters.

We demonstrate enhancement of thermoelectric performance of Si thin films by forming nanostructures in the film and on the surface. Formation of nanoholes (radius: 100 nm) by nanoimprint technique in a 300-nm-thick poly-Si thin film scatters thermal phonons and enhances thermoelectric performance by a factor of 3 [1]. We fabricated thermoelectric generator and found that the generated thermoelectric power was enhanced by 10 times by phononic crystal nanopatterning (Fig. 1). We also propose that surface nanostructuring is also a useful approach to enhance thermoelectric performance. Deposition of Al ultrathin (1 nm) Al film forms an amorphous Al/Si interface on a surface of a Si thin film and destroy thermal phonon wave packets [2]. As a result, thermal conductivity of a 70-nm-thick Si film with an Al deposition showed reduced thermal conductivity by 40% compared with the Si film without Al deposition. Planar-type Si TEGs were fabricated in an SOI wafer and thermoelectric performance was investigated around room temperature. The TEG with the Al thin film showed higher power density by 42% [3]. These simple, large area, and low-cost methods to enhance the thermoelectric performance of planar-type TEGs with high surface/volume ratio are highly practical and useful.

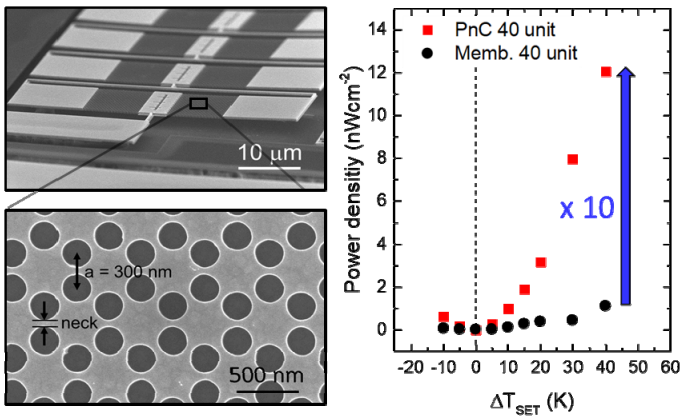

Fig. 1. A uni-leg type poly-Si thermoelectric generator with porous structures. The holes scatter phonons efficiently and resulted in higher power density by 1 order of magnitude compared with a plain membrane.

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