“Interdigitated design of a thermoelectric microgenerator based on silicon nanowire arrays“

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Abstract

Silicon nanowires thermoelectric properties are much better than those of silicon bulk. Taking advantage of silicon microfabrication techniques and compatibilizing the device fabrication with the CVD-VLS silicon nanowire growth, we present a thermoelectric microgenerator based on silicon nanowire arrays with interdigitated structures which enhance the power density compared to previous designs presented by the authors. The proposed design features a thermally isolated silicon platform on the silicon device layer of an SOI silicon wafer. This silicon platform has vertical walls exposing <111> planes where gold nanoparticles are deposited by galvanic displacement. These gold nanoparticles act as seeds for the silicon nanowires. The growth takes place in a CVD with silane precursor, and uses the Vapor-Solid-Liquid synthesis. Once the silicon nanowires are grown, they connect the silicon platform with the silicon bulk. The proposed thermoelectric generator is unileg, which means that only one type of semiconductor is used, and the second connection is made through a metal. In addition, to improve the thermal isolation of the silicon platform, multiple trenches of silicon nanowire arrays are used, up to a maximum of nine. After packaging the device with nanowires, we are able to measure the Seebeck voltage and the power obtained with different operation modes: harvesting mode, where the bottom device is heated up, and the silicon platform is cooled down by natural or forced convection, and test mode, where a heater integrated on the silicon platform is used to produce a thermal gradient.