Nanotech - Energy

Novel Cooling Devices based on Quantum Structures

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Host Professor: **Pr. K. Hirakawa**

Keywords: **Solid-state refrigeration, MEMS, Quantum structures**

Context

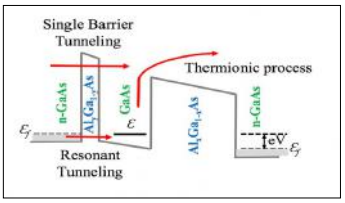

Fig. 1: Band structure of the thermionic cooling device

Goal:
Fabrication of novel thermionic cooling devices based on GaAs heterostructures using resonant tunneling and thermionic emission

Status of consensus problems:
Due to very high-density device integration, cooling of electronic/photonic devices is becoming extremely important.

Objectives

-Design and fabrication of thermionic cooling devices
-Measurement of the refrigeration properties
-Optimization of the cooling device structure

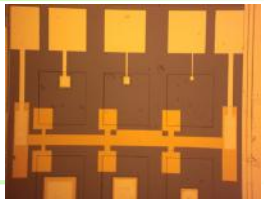

Fig. 2: Design of the device

Methods

1) Fabrication of thermionic cooling devices based on GaAs heterostructures using resonant tunneling and thermionic emission
2) Design of the MEMS thermometer
3) Integration of the thermionic cooling device on the MEMS thermometer and characterization of the cooling properties (Fig. 3)

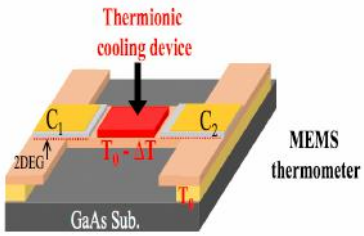

Fig. 3: Targeted sample structure

Results

Design and Fabrication of the thermionic cooling device based on GaAs heterostructures (Fig. 2)

Simulation of the I-V curve of the device (Fig. 4)

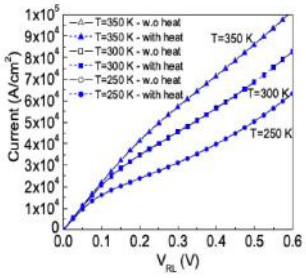

Fig. 4: Simulation of the I-V curve

Perspectives

(i) Integration of the thermionic cooling device on the MEMS thermometer
(ii) Measurements of the refrigeration properties
(iii) Optimization of the cooling structure by using a good thermoelectric material

Publications

This project was started in November 2016.
No publication to date.

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