

## Fabrication of low cost superlattices for the thermal management of electronic systems

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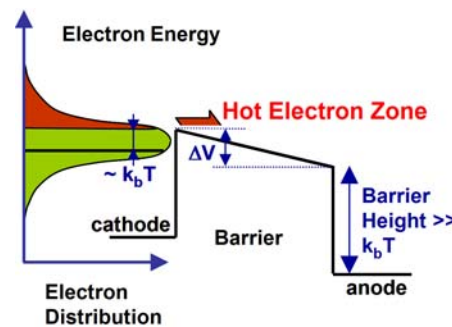
### Project Goals

The presence of millions of transistors on the surface in the order of 1mm<sup>2</sup> results in very localized heating in these electronic components. These 'hot spots', which can go up to several tens of degrees Celsius above the average temperature of the device, can be a source of tampering of the features of the component. The increasing complexity of electronic systems, whose integration is now three-dimensional, makes it even more difficult to evacuate the heat. The project, COFISIS' goal is using nanotechnology to, 1) Reduce the temperature of the localized hot spots in the electronic systems and integrated circuits, with acceptable manufacturing costs, 2) Recover the thermal energy "wasted" by the components to reduce the consumption of energy by the electronic systems.

### Principle

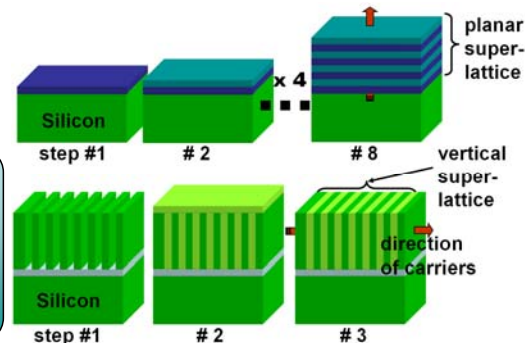
- Using high power thermoelectric superlattices. A **superlattice** = multilayer structure consisting of two materials with a succession of potential barriers.
- When the barriers are sufficiently small, the emergence of a ballistic thermionic transport can dramatically increase the thermoelectric power of the superlattices when compared to the bulk material, even including the filtering of the most energetic electrons.
- The proliferation of interfaces **reduces the conduction of phonons**, which are the main drivers of heat.

The project COFISIS proposes to make super-vertical lattices directly into the silicon, and not by successive deposits of planar layers to provide a technology compatible with industrial manufacturing processes and significantly reduce manufacturing costs.



*Nanoscale thermal transport and microrefrigerators on a chip [Shakouri, IEEE Proc. 08/2006].*

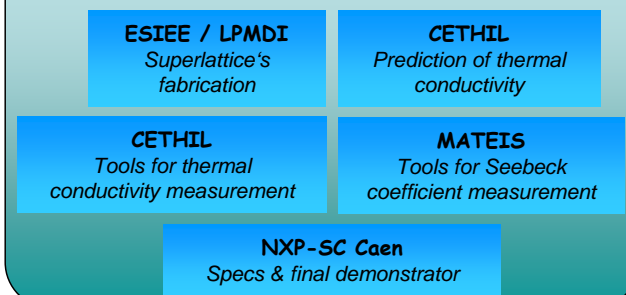
*Fabrication of the superlattices: (a) Classical approach (b) Our 'Low-cost' approach.*



### Challenges

- Fabrication of super-vertical lattices whose width between layers are sufficiently low for even partially optimized ballistic thermionic transport.
- Development of mathematical models for the heat conduction in heterogeneous nanostructures to help the optimization of superlattices.
- Developing experimental and prediction tools for measurement of the heat conduction and thermoelectric power, suitable for the nanometric scale.

### Organisation of the COFISIS consortium



Web:

[www.esiee.fr/~bassetp/cofisis.html](http://www.esiee.fr/~bassetp/cofisis.html)