



Institut Matériaux Microélectronique
Nanosciences de Provence

A novel structure for Cooling Nano-devices: The Quantum Cascade Cooler

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The need for new cooling devices:

Moore's Law: The number of transistors on microchips doubles every two years

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important for other aspects of technological progress in computing – such as processing speed or the price of computers.

Our World
in Data

Transistor count

50,000,000,000

10,000,000,000

5,000,000,000

1,000,000,000

500,000,000

100,000,000

50,000,000

10,000,000

5,000,000

1,000,000

500,000

100,000

50,000

10,000

5,000

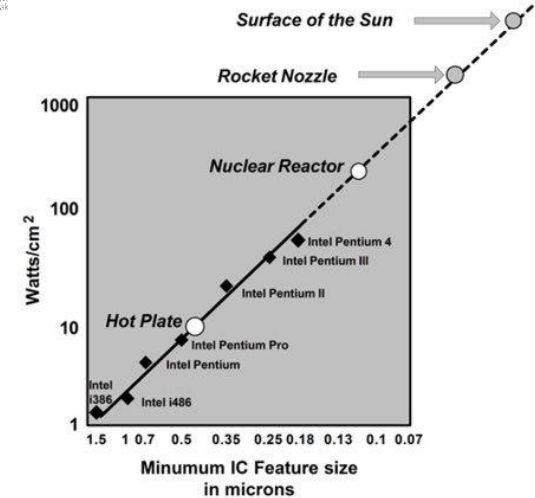
1,000

Year in which the microchip was first introduced

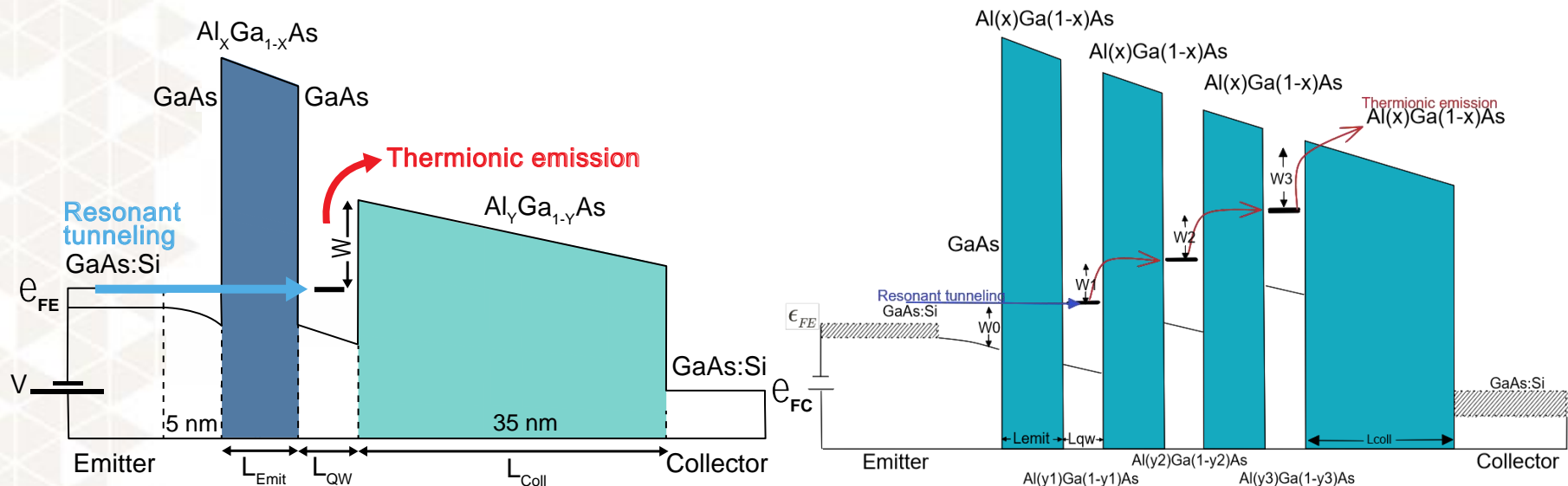
Data source: Wikipedia (wikipedia.org/wiki/Transistor_count)

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Cooling nano-devices based on thermionic emission:

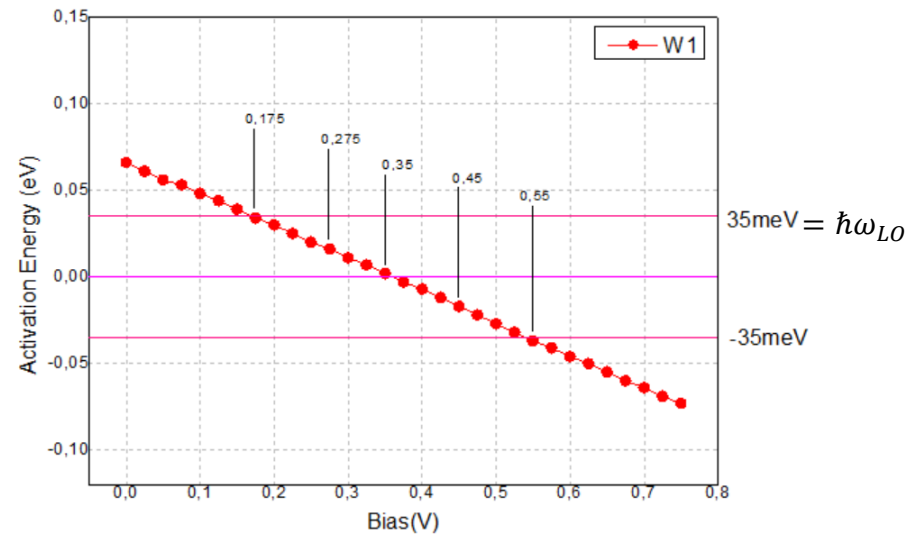
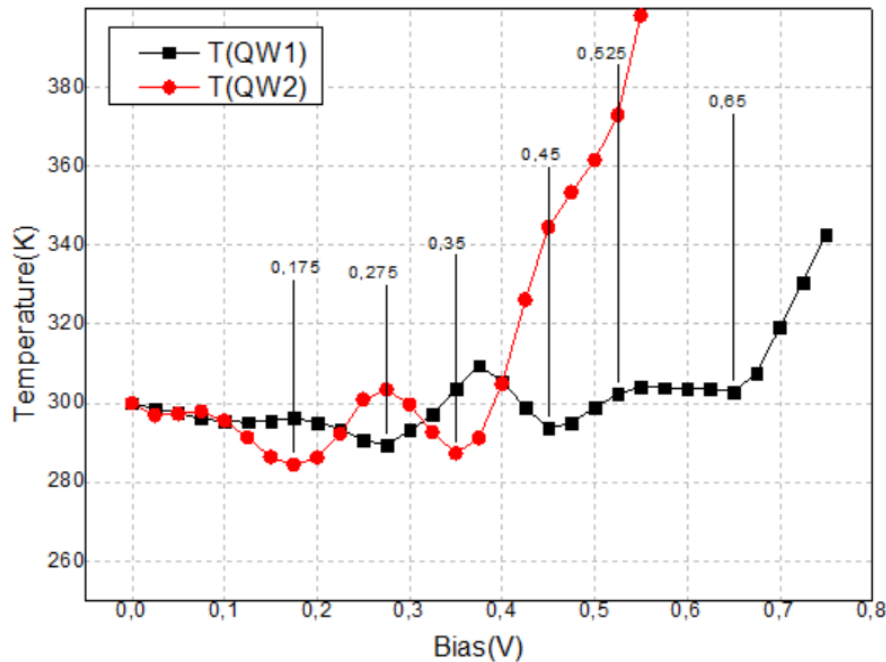


[1] M. Bescond et al. J. Phys.: Condens. Matter 30, 064005 (2018).

Key message :

- Injecting cold electrons by resonant tunneling and extracting hot electrons by thermionic emission \Rightarrow Cooling

Temperature oscillations :



Key message :

- Average electron temperatures inside the are oscillating
- These oscillations depend on the activation energy W1

