On a timescale, the nanomechanical sensing applications will be the first to reach the commercial level, as in these ones, the packaged NEMS resonators can be easily technologically designed to operate in vacuum conditions.

The “top-down” resonant NEMS approach will extend the MEMS technologies below 0.1 μm size and try to exploit its well established subtractive processes, to which specific nanotechnology steps, like electron beam lithography for patterning ultra-small “line” width, or dip pen nanolithography for chemical functionalization will be added.

The “bottom-up” additive NEMS approach, which is based on supramolecular chemistry principles, molecular self-assembly and recognition is in the very early stage, today. The molecular electronics is growing from single-molecule device to molecular computational circuitry, while novel concepts of the rotaxane-based bio-mimetic nanomachines are proving the capability for future artificial muscle applications. The resonant vibration of the molecular architectures is still to come.

The mixed “top-down-bottom-up” approach is combining the above two approaches, and thus both subtractive and additive processes are mixed and matched for the realization of the resonant structure.

The resonant beam is either built atom-by-atom from silicon by vapor-liquid-solid epitaxy, or by carbon technology, where CNT or graphene are selectively grown or transferred to the required position on the chip.

Recently, novel differential concepts and functionalization routes for self-assembled sensing monolayers and ultrathin sensing layers are expected to improve the long term stability of the solid state IC-based chemical sensing, and hopefully open the way to commercialization.

Deep understanding of the fundamental science and technology principles is the foundation of the future innovative developments, which may bring disruptive discoveries in the field of material-process-device, changing the present vision and bringing unforeseen evolutions in the field of future nanotechnology and applications.

So, even today, there is still “plenty of room” for nanotechnology innovation, and young generations have enough space to play and bring their contribution to the future of nanotechnology.

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