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A VISION ON RESONANT NANO-ELECTRO-MECHANICAL SENSORS

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Abstract. *In this paper, we present a possible vision of the resonant nano-electro-mechanical system (NEMS) technology and their sensing applications. The work is briefly describing the major milestones of the nanotechnology progress starting from the moment when it was existing only in the imagination of the science and technology pioneers, until the stage of the first commercial applications. Here, we are focusing on the status and roadmap of the resonant NEMS technology, as the largest technology platform with the highest mass detection capability and huge potential in nanomechanical, chemical and biological sensing, and future computing science applications. Today, there are multiple technological possibilities for the realization of these resonant NEMS systems, all of them being described here in the so-called "top-down"," bottom-up" or the mixed" top-down-bottom-up" approaches. The biggest challenge of today's nanotechnology research on resonant NEMS for gas and biomolecule detection is the transition from the present state of proof of principle for zeptogram detection in ultra-high vacuum and cryogenic temperatures by means of external magnetic actuation and detection to the room temperature operation and atmospheric pressure ,as well as on-chip excitation and readout, as required by real application. Finally, our novel concepts on differential sensing and associated functionalization routes for resonant NEMS gas sensing are described.*

Keywords: NEMS roadmap, resonant NEMS sensors , top-down, bottom-up, chemical NEMS sensors, SO_2 detection

1. Introduction

The early stage of nanotechnology was born more than fifty years ago, in the mind of the visionary scientist, Richard Feynman, who challenged the entire scientific community towards the technology of controlling the atoms, by their identification, visualization, manipulation, and finally chemically binding them one-by-one in order to build new structures and devices. Thanks to his famous talk, "There is plenty of room at the bottom" [1], from 1959, Feynman is considered the father of nanotechnology. In 1965, Gordon Moore was envisioning the twofold increase of integrated circuits complexity, each twelve months [2], and this statement became 'Moore's law", which, with small rate changes is still valid today, when the electronics is already living the nanoelectronics era, with the "line" width of the integrated circuits of about 32 nm. The term of "nanotechnology" was coined by Norio Taniguchi, in 1974, while he was doing basic research in the field of high precision machining of the hard coatings and materials [3]. Finally, it is worth to

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