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Microcantilever tools in biosensing: A brief survey

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Biosensors based on microcantilevers have become a promising tool for directly detecting biomolecular interactions with great accuracy. Changes in microcantilevers resonant frequency or their bending can be monitored by optical (Bragg fiber interferometry or laser beam deflection in Atomic Force Microscopy) and electrical techniques: piezoresistive, capacitive, magnetic (magneto-resistive, strictive or motive), electron tunneling current. Piezoresistive microcantilevers are widely spread in cell mechanobiology, ranging from tissue level to individual proteins and DNA. They are made of various materials (ultrathin steel foils, gold probes, glass, soft polymers, hard silicon-based devices or carbon nanotubes), using different fabrication processes: integrated circuitry, soft lithography or focused ion beam etching. Piezoresistive microcantilevers cover a lot of shapes (I, A, V, U, "hook", "putter"), sometimes optimized by finite element analysis. They exhibit high or low aspect ratios (length vs. width) depending on the type of biological application. For improving the measurement sensitivity, apart from the mechanical "shaping", several electronic methods of gain augmenting are used, e.g. the piezoresistive effect in silicon resulting in a resistance change with applied stress, as a function of crystal orientation, dopant type and doping concentration. A smart electromechanical "combination" consists in a field effect transistor located under a vibrating microcantilever, where pre-bending significantly increases the sensitivity (US Patent 2012). Also, multiple microcantilever arrays have been introduced for highly sensitive detection of biomolecules in disease diagnostics, genomics research and other applications in biosensing.

Biography

Dan Mihai Ştefănescu received his B.S. degree in Applied Electronics (1969), M.S. in Experimental Stress Analysis (1983) and Ph.D. cum laude in Electrical Engineering from the "Politehnica" University of Bucharest, Romania (1999). He was the Head of Metrology and Instrumentation with the National Institute for Aerospace Research, Bucharest. He completed a Post-Doctoral Fellowship (NATO grant) on Knowledge-based Intelligent Systems for Selecting Industrial Sensors, with the Twente University of Enschede, The Netherlands. He was Visiting Scientist with the Korean Research Institute of Standards and Science and with the Center for Measurement Standards, Hsinchu, Taiwan. He is currently Senior Consultant with the Romanian Measurement Society and the Romanian representative for IMEKO (International Measurement Confederation). His current research interests include electrical measurement of mechanical quantities, material testing installations and metrological procedures for multicomponent transducers.

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