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Recent developments in magnetic impedance biosensors and related medical devices

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Early detection of cancer cells in the body greatly increases the chances of successful treatment. While traditional methods, such as visual identification of malignant changes, cell growth analysis, specific-ligand receptor labeling, or genetic testing often require lengthy analysis, a combination of ultrasensitive magnetic field sensors with functionalized magnetic nanoparticles offers a promising approach for a highly sensitive, simple, and quick detection of cancer cells and biomolecules. In this talk, I will review recent progress in the development of magnetic impedance biosensors using nanoparticles. I will present a new approach that integrates the magneto-resistance (MR), magneto-reactance (MX), and magneto-impedance (MI) effects to develop a functional magnetic biosensor with tunable and enhanced sensitivity. The MX-based probe shows the most sensitive detection of superparamagnetic nanoparticles (~10 nm diameter) at low concentrations. A novel biosensor based on the MX effect of a soft ferromagnetic ribbon with a micro hole-patterned surface has been developed, demonstrating its high capacity for the detection and quantification of anticancer drugs and proteins tagged to Fe_3O_4 nanoparticles, as well as Lewis lung carcinoma (LLC) cancer cells that have taken up Fe_3O_4 or MnO nanoparticles. Finite element simulation fully supports the experimental observations. Finally, novel classes of magnetic nanostructures for advanced biosensing and new exploration in medical diagnostics will be discussed.

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A novel optical bioassay for the detection of pesticides in marine environment exploiting an array of green photosynthetic microalgae

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Increasing pollution of marine environment requires development of sensitive, cheap and adaptable early warning systems for on-site monitoring of chemical contaminants. Herein, we present an optical bioassay exploiting an array of green photosynthetic microalgae as a promising alternative for monitoring seawater pollutants, which can provide rapid and quantitative toxicity information while assessing the harmful effect on marine ecosystems. For bioassay optimization, several microalgae species from Chlorophycea, Trebouxiophycea, dinoflagellates, diatoms and Eustigmatophycea groups with different marine and non-marine origins were studied in marine environmental conditions. The lipid content of selected species was analyzed, since lipids have been proposed to be involved in protection mechanisms against salt stress. The fluorescence response of the algae photosystem II was examined in real-time in the presence of three commonly found marine pollutants that act as photosynthesis inhibitors: Simazine, diuron and irgarol. Algae from marine origin were discarded because of their low fluorescence response. The chemical pollutants were tested alone or in combination in a seawater matrix with non-marine algae species, and results validated by LC-MS. Pesticides were detected in seawater samples in the ng/L - low µg/L range, and a synergistic effect was observed when analyzing pesticide mixtures. The different algae species showed slightly diverse sensitivities for the three pollutants, being *Chlorella mirabilis* the most sensitive with a limit of detection of 67 ng/L for diuron. Therefore, a green microalgae-based bioassay was successfully developed for real-time monitoring of marine water quality and evaluation of bio-toxicity by the fluorescence analysis of photosystem II.

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