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D2Dx-From diameter to diagnostics: Gold nanoparticle-enabled dynamic light scattering assay for chemical and biological target detection and analysis

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Dynamic light scattering (DLS) is an analytical technique used routinely to measure the hydrodynamic sizes of particles with diameters in the nanometer region. Gold nanoparticles are known for their exceptional light scattering properties. By combining the strong light scattering property of gold nanoparticle probes with the size measurement capability of DLS, a new technique named as D2Dx (from diameter to diagnostics) for chemical and biological target detection and analysis was developed. Gold nanoparticles can be surface-modified with various chemical ligands, antibodies or other binding molecules to form gold nanoparticle probes. The binding of chemical or biological target analytes with their specific gold nanoparticle probes can lead to nanoparticle cluster formation, and subsequently, an average particle size increase of the assay solution. Such particle size increases can be measured by DLS, and correlated to the quantity of the target analytes. D2Dx is a single-step homogeneous solution assay, easy to perform, of low cost, and has excellent sensitivity and reproducibility. So far, this technique has been applied successfully for quantitative detection and analysis of a wide range of chemical and biological targets, including proteins, DNAs, viruses, carbohydrates, small chemicals, toxic metal ions, food and environmental toxins. In this talk, I will explain the principle of D2Dx, give an overview on the application potentials of this technique in biomedical research, food safety and environmental protection, and then present several specific examples of using D2Dx for protein detection and analysis.

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Environmental estrogens: An analytical challenge

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Estrogenic compounds, particularly the synthetic estrogenic steroids-ethinyl estradiol (EE2) and mestranol (MeEE2) and natural hormone steroids-estrone (E1), estradiol (E2) and estriol (E3), have attracted a great deal of scientific and public attention during recent years due to their occurrence in surface waters and sewage treatment plant effluents and their potential adverse effects on the development and reproduction of fish, wildlife and even human beings. In this presentation, we will focus on our research on the occurrence, sources, and microbial and photochemical degradation of both synthetic and natural estrogenic steroids in fresh and marine aquatic environments and their effects on public health during the past decade. To face analytical challenges for determining trace amounts of estrogenic steroids in natural waters, GC-MS and HPLC analytical methods have been developed. The developed methods were applied to the water samples periodically collected from wastewater treatment plants, lakes, Acushnet River and Buzzards Bay. The interested compounds were detected in several of water samples in nano to micro-gram per liter concentration range, can certainly cause fish feminization and may also contribute to the observed declines in American lobster population in Buzzards Bay. Microbial and photochemical degradation of E1, E2, E3, EE2 and MeEE2 have been also investigated in seawater as well as in waste, lake and river waters as a comparison. The microbial degradation of synthetic steroid estrogens is extremely slow with a half-life of longer than 70 days in seawater. However, the photo degradation of these compounds is much faster with a half-life of 17 hours for EE2 and 19 hours for MeEE2. Humic and other dissolved organic substances significantly accelerate the sunlight-induced photo degradation of estrogenic steroids. Transition metal Fe(III), nitrate and nitrite can further catalyze the photochemical decomposition of these steroids.

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