Edward P C Lai, Med Chem (Los Angeles) 2018, Volume 8
DOI: 10.4172/2161-0444-C2-041

18th International Conference on
Pure and Applied Chemistry
August 31- September 01, 2018 | Toronto, Canada

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Environmentally toxic and biochemically active contaminants binding onto metal oxide nanoparticles in water

The interplay of metal oxide nanoparticles, environmental pollution and health risks is key to all industrial and drinking water treatment processes. A unifying methodology will be presented for the sensitive and selective determination of environmentally toxic and biochemically active contaminants that are bound onto metal oxide nanoparticles (TiO_2, ZnO and CeO_2) in water. The method begins with a sample treatment step that encapsulates all polydopamine-coated waterborne nanoparticles into liposomes that can be prepared from lecithin. Gel filtration chromatography is useful for the analytical investigation of metal oxide nanoparticles in water, their coating with polydopamine and their encapsulation within lecithin liposomes. Screening by flow injection analysis demonstrated the excellent homogeneity of PDA-TiO_2 nanoparticles. Transmission electron microscopy helped visualize the bimodal size distribution and morphology shape of the lecithin liposome-encapsulated PDA-TiO_2 nanoparticles. Encapsulation of graphene quantum dots by liposomes would allow for monitoring of nanoparticle-loaded liposomes to ensure their complete removal by membrane ultrafiltration from treated water. Although polytetrafluoro-ethylene membrane filtration proves to be effective for nearly quantitative removal of liposomes encapsulating PDA-TiO_2 nanoparticles, free lecithin liposomes can only be eliminated by using alum to coagulate them for sedimentation in water treatment. For quantitative analysis, centrifugation can be applied to concentrate the liposomes after the supernatant water is discarded. A surfactant disintegrates the liposomes to set the nanoparticles free. Contaminants are desorbed from their surfaces using chemistry, biochemical interaction and electrospray ionization for mass spectrometric detection at trace levels.

Biography

Ed Lai obtained his Ph.D. degree in Analytical Chemistry from the University of Florida (U.S.A.) in 1982, under the supervision of Professor Jim Winefordner. He is currently Full Professor (Chemistry & Biochemistry) at Carleton University and is a Fellow of the Chemical Institute of Canada. He has published over 150 scientific papers/editorials and presented over 135 talks/posters at conferences. His research interest is instrumental analysis of biochemical and environmental samples, using photochemical, electrochemical, chromatographic and electrophoretic techniques to develop new analytical methods for enhanced sensitivity and selectivity.

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