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Multi-Functional Metal Oxides as Gas Sensors, Photo-Catalysts and Bactericides

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Abstract : Nano- to submicron size particles of narrow particle size distribution of semi-conducting TiO_2, ZnO, NiO, CuO, Fe_2O_3 have been synthesized by novel hydrazine method and tested for their gas sensing, photocatalytic and bactericidal activities and the behavior found to be enhanced when the oxides in the thin film forms, that obtained in a specially built spray pyrolysis reactor. Hydrazine method is novel in the sense, say, the UV absorption edge of the white pigment grade wide band gap (~3.2eV) TiO_2 and ZnO shifted to the visible region turning into yellowish particles, indicating modification occurring the band structure. The absorption in the visible region makes these oxides visible light sensitive photocatalysis in degrading pollutants, especially the organic dyes which otherwise increase the chemical oxygen demand of the drinking water, enabling the process feasible not under the harsh energetic UV radiation regime. The electromagnetic radiations on irradiation produce electron-hole pairs Semiconductor + $h\nu \rightarrow e^- + h^+$ The electron-hole pairs thus produced form Reactive Oxygen Species, ROS, on the surface of the semiconductors, O_2(adsorbed)+$e^- \rightarrow O_2\bullet$ - superoxide ion OH-(surface)+$h^+ \rightarrow \bullet$OH - Hydroxyl radical The ROS attack the organic material and micro-organisms. Our antibacterial studies indicate the metal oxides control the Biological Oxygen Demand (BOD) of drinking water which had beyond the safe level normally found in the municipal supply. Metal oxides in the thin film form show overall enhanced properties and the films are reusable. The results of the photodegradation and antibactericidal studies are discussed. Gas sensing studies too have been done to find the versatility of the multifunctional metal oxides.

Keywords : hydrazine method, visible light sensitive, photo-degradation of dyes, water/airborne pollutant
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