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Nanostructure directing sensor interfaces created from nanoparticle island sites deposited to micro- porous arrays

Novel nanostructured metal oxide island sites are made to decorate a microporous/nanoporous array forming efficient sensor platforms. These nanoparticle metal oxide island sites, formed from easily obtained solutions allow the formation of sensor platforms distinct from film-based coating. The nanostructure directing acidic metal oxide sites which vary in their Lewis acidity control the electron transduction process. The interaction of analytes with these island sites varies in a predictable manner and can be modified through in-situ functionalization of their Lewis acidity. The microporous structure allows rapid Fickian diffusion of analytes to the active nanostructure island sites whose reversible interaction dominates the sensor response as it requires low energy consumption. Highly accurate repeat depositions are not required. The island sites are deposited at sufficiently low concentration so as not to interact electronically with each other. The response time of these interfaces is more rapid than film-based depositions, which require a more lengthy diffusion time. The sensors are reversible. The nanoporous structure prevents sintering of the island centers at elevated temperatures. The concentration of detection centers can be made to produce an optimum matrix of enhanced sensor responses and force a dominant, distinct, analyte-interface physisorption (rather than chemisorption). The produced semiconductor interface is easily functionalized to create an enhanced range of nanoparticle semiconductor sites. The matrix provides a sensitive means of transferring electrons that are easily detected. The sensors operate at room temperature as well as elevated temperatures. Low energy magnetic field signal enhancement can be achieved with transition metals. Contaminated sensors can be readily rejuvenated. Pulsed mode operation ensures low analyte consumption and high analyte selectivity and further provides the ability to rapidly assess false positive signals using Fast Fourier Transfer techniques, Solar pumped sensors requiring low light levels (≤ 1 Watt) have been demonstrated. Water vapor contamination can be greatly if not entirely reduced. The modeling of sensor response with a new Fermi energy distribution based response isotherm is found to be superior to other isotherms. Sensors can be made to operate efficiently for two gases simultaneously. Modes of extending these studies to multiple gas arrays have been considered.

Speaker Biography

James L. Gole received the B.S. degree in chemistry from the University of California, Santa Barbara where he was an NSF Research Fellow (1967). He received the Ph.D from Rice University (1971) where he was a Phillips Research Fellow. He was an NSF Post-Doctoral Fellow at Columbia University from 1971 to 1973. He joined the Department of Chemistry at M. I.T. in 1973 and in 1977 he joined the School of Chemistry at the Georgia Institute of Technology where he became Professor of Chemistry in 1981. In 1983 he joined the School of Physics, GIT, where he is currently Professor of Physics. In 2002, he became a joint Professor in Mechanical Engineering. He is a Fellow of the American Physical Society (APS) and the American Association for the Advancement of Science (AAAS). Dr. Gole is interested in high temperature materials nanosynthesis, the chemical physics of surfaces, porous silicon structures for hybrid nano/microsensors and nanostructure enabled photocatalytic reactors, nanostructured directed sensing, and the IHSAB principle. He holds 27 patents and has published over 300 papers. Dr. Gole has been a recipient of the Sustained Research Award of the Sigma Xi Research Society. He has been named GIT Outstanding Research Author. In 2005, he was named Outstanding Undergraduate Research Mentor. He was also recipient of the Professional of the Year Award from Worldwide Who's Who.

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