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The role of nobel metal nanoparticles in catalysis and photocatalysis

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Micron size noble-metals are called "noble" due to their limited reactivity compared to the other metals. Therefore they remain inactive in certain reactions. Depending on the nature of the reaction, some noble metals such as Palladium (Pd) and Platinum can exhibit a good catalytic activity toward the removal of NOx. For example Pd and Pt is a very good oxidation catalyst that used inthe oxidation of HC and CO in the catalytic convertor and exhibitsa good resistance to poisoning (i.e. sulfur poisoning). Nanomaterials play important role in many technological areas due to their unusual properties due to their small particle size, high surface area, and densely populated unsaturated surface coordination sites. Depending on their size, shape, and preparation conditions, nanomaterials can exhibit unique properties (electrical, optical, magnetic, and catalytic) which are different from their bulk material properties. Nanophase noble metal catalysts could potentially provide significantly improved catalytic performance over conventional micron size noble metal catalysts. The discovery of highly effective supported metal (Cu, Au) on metal-oxide Nanocatalysts opens new opportunities in Nanocatalysis research. For example, gold-based Nanocatalyst are distinct technologically, in that they function at (or below) normal temperature and humidity, carbon monoxide (CO) to carbon dioxide (CO_2)conversion at room temperature, catalyzing air-purification via complete combustion of noxious waste gases using ambient oxygen as an oxidant. Recently, we reported the synthesis and characterization of supported Pd, Au and unsupported bimetallic Pd-Au nanoparticle catalysts for CO oxidation. Our nanoparticle catalysts consist of small Pd or Au nanoparticles (5-10 nm) homogeneously dispersed on the surfaces of larger nanoparticle oxide supports such as CeO_2 (40-60 nm). Our results indicate that individual Pd, Au and CeO_2 nanoparticles exhibit higher activities as compared to the corresponding micron-sized particles. We attributed these results to higher activity of the Pd/CeO_2 nanoparticle catalyst might be attributed to the large surface area, highly dispersed Pd nanoparticles, possible non-stoichiometric CeO_{2-x}, and the nature of the surface oxygen species on CeO_{2-x}. The deposition of noble metal nanoparticles on the surface of polar semiconductor or insulator particles can enhance the Photocatalytic activity and by harvesting visible light due to their surface Plasmon resonance while the metal-semiconductor interface efficiently separates the photogenerated electrons and holes. In this regard, we reported a heterogeneous Ag/ZnO Photocatalysis with high Photocatalytic activity toward methylene blue degradation and visible range absorption. The enhanced Photocatalytic activity was achieved by surface modification of ZnO nanoparticles through the addition of small amount (< 1%) of noble metals such as Ag, Pd, and Au. We attributed the Photocatalytic activity of the Ag/ZnO Photocatalyst to Plasmon surface effect of Ag nanoparticles and interaction of Ag with ZnO. Ag nanoparticles act as an electron sink, promoting interfacial charge transfer reducing charge recombination. This work demonstrates the application of supported noble metal nanoparticles Photocatalyst for different applications such as water and anti-microbial treatment.

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Performance analysis of cryogenically treated carbide end mills by experimental and FEA

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The main objective of the research was to study the effect of cryogenic treatment and double tempering on the tool life of Carbide end mills in machining EN47-Spring Steel cutting tool components. Carbide end mills were cryogenically treated at -175°C and double tempered at 200°C. Milling exercises were carried out using the treated and untreated tools on EN47-spring steel reamer components at different machining conditions. The treated end mills showed 60% greater tool life in pocket milling when compared with that of the untreated carbide end mill. FEA results of the temperature profile of untreated and treated carbide end mill at 31.4 m/min speed were found to be 23°C and 20°C respectively.

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