Sample Literature Review

Project title: Investigating the Anti-bacterial Properties of Metal and Metal Oxide Nanoparticles

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In recent years, there has been growing interests and investments in research on nanomaterials, minuscule substances having at least one dimension within the nanometer scale, including nanoparticles, nanowires and nanofilms (Cao, 2006). At the nanometer scale, these materials exhibit vastly different physical and chemical properties from their bulk materials: crystals in the nanometer scale have much lower melting points, ferromagnetic materials may lose their ferromagnetism when diminished to nanometer size, semiconductors become insulators and vice versa, solids become liquids at room temperature and pressure, and inert chemicals like gold become excellent catalysts. In addition to these are biological anti-bacterial properties. Nanomaterials have such amazing properties because of their high proportion of surface atoms, in comparison to bulk materials. Thus, there are more atoms at the surface with unsaturated bonds, capable of taking part in interactions.

The antibacterial properties of nanoparticles are of interest because of their obvious potential applications. Some metal-based nanoparticles, particularly silver nanoparticles, exhibit excellent bacteriocidal and bacteriostatic properties (Sondi & Salopek-Sondi, 2004; Panacek *et al*, 2006). It is well known that silver ions and silver-based compounds are highly toxic to as many as 12 species of bacteria, including *E. coli* (J.S. Kim *et al,* 2007). According to Kim *et al*. (2007), the mechanism of the inhibitory effects of Ag ions on microorganisms is only partially known. Several studies (Hamouda *et al*, 2000; Dibrov *et al*, 2002; Dragieva *et al*, 1999) have reported that the positive charge on the Ag cation plays a key role in its antimicrobial activity via electrostatic attraction between the negatively charged cell membrane of microorganism and positively charged nanoparticles. In other studies

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investigating the killing mechanisms of silver nanoparticles, the antimicrobial activity of silver nanoparticles on Gram-negative bacteria was correlated to the concentration of Ag nanoparticles, which governs the formation of pits in the bacterial cell wall, allowing the accumulation of silver nanoparticles to affect the membrane's permeability, resulting in cell death (Sondi & Salopek-Sondi, 2004). A report by Lok *et al.* (2006) states that silver nanoparticles have been found to destabilize the bacterial outer membrane and deplete the levels of intracellular ATP. Several recent publications postulate that silver nanoparticles may adhere to the surface of the cell membrane, thereby disrupting cellular functions such as permeability and respiration (Panacek *et al*, 2006); silver nanoparticles may cause damage, after penetration, by interacting with phosphorus- and sulphur-containing compounds, including DNA, for silver tends to have a high affinity to react with such compounds (Hatchett, 2004).

Given the high toxicity of silver nanoparticles on bacteria, there are extensive biological, biomedical, and pharmaceutical applications (Sondi & Salopek-Sondi, 2004) of nanoparticles exhibiting antibacterial properties, including widespread products where bacterial growth should be inhibited. The antibacterial activity of the nanoparticles may be used in medicine to reduce infections in burn treatment, arthroplasty, to prevent bacteria colonization on prostheses, catheters, vascular grafts, dental materials and dental resins, as well as integration into textile fabrics, or even for water treatment (Panacek *et al*, 2006). In addition, they can be incorporated into domestic and car air-conditioner filters, floor drain traps, shoe and insole lining, bandages or plasters, refrigerators, storage containers, and antibacterial soaps, detergents or washing liquids.

References

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More in-text citing styles:

- Studies by Mitch and Albom (1999, 2003) showed that … …
- It was observed by Merck (1997) that … …
- John *et al* (2007) reported that … …
- Sondi (2001) found that … …