Research Paper

Volume : 2 | Issue : 7 | July 2013 • ISSN No 2277 - 8179

An overview: antimicrobial packaging

Engineering

KEYWORDS : nanoparticles , sterile , antimicrobial , packaging, bio film,am

Bassan H. S.	ME Scholar , Production Engineering Department, PEC University of Technology, Chandigarh
Randhawa J. S.	Asst. Professor, Production Engineering Department, PEC University of Technology, Chandigarh
Suri N. M.	Associate Professor, Production Engineering Department, PEC University of Technology, Chandigarh

ABSTRACT

Packaging in medical instruments is important for maintaining sterility. At the end of a correct sterilization process, products inside the sterilizer chamber are sterile. In a hospital or clinic it is important that all medical instruments used for treating patients are absolutely safe for use, the chance for spreading of diseases should be kept as small as possible The air in the room where the sterilizer is installed contains dust particles, which may carry micro-organisms. So when taking out the load from the sterilizer, it soon will be contaminated again. In addition usually sterile goods are stored for quite some time before they are used, and moreover they are transported through the hospital to the place they are to be used. when not protected, the goods will definitely be decontaminated by the time they are used. . The proper selection, use, and performance of sterilization packaging systems is crucial to achieve sterilization of the package contents, maintain sterility of the contents until the package is opened for use, and permit removal of the contents without contamination

Introduction:

In recent years, materials with antibacterial property are widely used in food and pharmaceutical and surgical packaging industries. The synthesis of antibacterial materials has been studying for a long period.In many studies, microorganisms such as bacteria have a strong tendency to populate surfaces, giving rise to a complex and strongly adhering microbial community named ''biofilm''. These microorganisms can colonize a wide variety of surfaces including food packaging and medical devices, this colonization leading to biofilm formation. Biofilms result from the accumulation of organic molecules, microorganisms and metabolites and are ubiquitous on surfaces submerged in aqueous environments. A reduction of surfaces contamination could be obtained through a well adapted choice in the materials to use or through modifying them by way of adapted surface treatments. Biofilms are difficult to eradicate using conventional cleaning and disinfection treatment. Consequently, preventing biofilm formation by incorporating antimicrobial products onto surface materials would be a better option than treating it. Recently, antibacterial polymers have gained an increasing attention because they could offer different interesting properties. They could be bactericidal (to kill bacteria), bacteriostatic (to prevent bacterial proliferation) or antiadhesive (to inhibit surface bacterial adhesion and biofilm formation). The emerging infectious diseases and the development of drug resistance in the pathogenic bacteria and fungi at analarming rate is a matter of serious concern. Despite the increased knowledge of microbial pathogenesis and application of modern therapeutics, the morbidity and mortality associated with the microbial infections still remains high [1]. Therefore, there is a pressing demand to discover novel strategies and identify new antimicrobial agents from natural and inorganic substances to develop the next generation of drugs or agents to control microbial infections. Prior to the extensive use of chemotherapeutics in modern health care system, inorganic antimicrobials such as silver and copper were used since ancient times to treat microbial infections [2]. In the recent times, the advances in the field of nanosciences and nanotechnology has brought to fore the nanosized inorganic and organic particles which are finding increasing applications as amendments in industrial, medicine and therapeutics, synthetic textiles and food packaging products [3]. Nanoparticles usually ranging in dimension from 1-100 nanometers (nm) have properties unique from their bulk equivalent. With the decrease in the dimensions of the materials to the atomic level, their properties change. The nanoparticles possess unique physico-chemical, optical and biological properties which can be manipulated suitably for desired applications [4]. Moreover, as the biological processes also occur at the nanoscale and due to their amenability to biological functionalization, the nanoparticles are finding important applications in the field of medicine [5]. The nanoparticles are broadly grouped into organic and inorganic nanoparticles. The latter have gained significant importance due to their ability to withstand adverse processing conditions [6]. Currently, the metallic nanoparticles are thoroughly being explored and extensively investigated as potential antimicrobials. The antimicrobial activity of the nanoparticles is known to be a function of the surface area in contact with the microorganisms. The small size and the high surface to volume ratio i.e., large surface area of the nanoparticles enhances their interaction with the microbes to carry out a broad range of probable antimicrobial activities. Metal nanoparticles with antimicrobial activity when embedded and coated on to surfaces can find immense applications in water treatment, synthetic textiles, biomedical and surgical devices, food processing and packaging [7]. Moreover, the composites prepared using metal nanoparticles and polymers can find better utilization due to the enhanced antimicrobial activity. main focus on the role of various metallic nanoparticles as potential antimicrobials and the possible mechanism of their inhibitory actions. The increasing application of nanoparticles as antimicrobials in industries, medicine, cosmetics, textiles and food packaging which requires the assessment of the toxicity and risks associated with these particles will also be reviewed.

RESEARCH RALATED TO ANTIMICROBIAL PACKAGING

Among various metal particles, copper nanoparticles have attracted more attention because of their catalytic, optical, electrical and antifungal/antibacterial applications [8,9]. Copper nanoparticles have been prepared using the methods such as thermal reduction [10], vacuum vapor deposition [11], microwave irradiation methods [12], chemical reduction [13], and laser ablation [14]. The above methods use oxygen-free atmosphere to synthesize copper nanoparticles because it easily oxidizes. But the polyol method is used to synthesize highly monodispersive copper nanoparticles in air atmosphere. The polyol itself acts as a reducing agent for nanoparticle preparation. In addition, it acts as a stabilizer, limiting particle growth, and prohibiting agglomeration. The polyolmethod is a low temperature method and it is also used to prepare metal oxides and metal chalcogenides [15]. The synthesis of copper nanoparticles by polyol method was reported by Park et al. [16]. Zhao et al. [12 reported the synthesis of microwave induced polyolprocess synthesis of copper nanoparticles with controlled morphology. The metal nanoparticles such as Ag, Cu etc., are found to have antibacterial activity [17]. The bactericidal effect of metal nanoparticles has been attributed to their small size, and high surface to volume ratio, which allow them to interact closely with microbial membranes and it is not merely due to the release of metal ions in solutions [18]. The antibacterial properties of the metal nanoparticles find applications in various fields such as medical instrument, and devices, water treatment and food processing. The antibacterial effect of copper nanoparticles was reported by Yoon et al . [19]. Cioffi et al. [20] have reported the antifungal and bacteriostatic properties of copper nanoparticles [21]To prepare antimicrobial films, different synthetic antimicrobial chemicals have been incorporated into packaging materials including organic or inorganic acids, metals, alcohols, ammonium compounds or amines [20][21] The US Environmental Protection Agency (EPA) has approved registration of copper as an antimicrobial agent which is able to reduce specific harmful bacteria linked to potentially deadly microbial infections (European Copper Institute, 2008). The emergence of nanoscience and nanotechnology in the last decade presents opportunities for exploring the bactericidal effect of metal nanoparticles. The bactericidal effect of metal nanoparticles has been attributed to their small size and high surface to volume ratio, which allows them to interact closely with microbial membranes and is not merely due to the release of metal ions in solution. The introduction of antimicrobial agents into food packaging material helps to prolong the shelf life of food products by inhibiting the growth of microorganism. AM polymers can be used in several food related applications including packaging (Hotchkiss, 1997). It can extend the shelf life and promote safety by reducing the rate of growth of specific microorganism by direct contact of the package with the surface of solid foods (e.g. meats, cheese, etc.) or in the bulk of liquids (e.g. milk or meat exudates) The effectiveness of AM film to inhibit the microbial growth had been proved by a lot of researchers. The application of AM agent into food packaging could effectively used in not only in the form of film but also as containers and utensil (Han, 2000). The main aim of active packaging is to change the condition of packaged food in order to extend the shelf-life (Ahvenainen, 2003). This practice can improve food safety and sensory properties, while maintaining the quality of packaged food. Antimicrobial agents have a specific inhibition activity against particular microorganisms. The selection of an AM agent therefore depends primarily on its activity against the target microorganisms (Ahvenainen, 2003). Many other factors, however, need to be considered when designing AM packaging systems. Specific gravity, water solubility, organoleptic properties, toxicity and resistance to microorganisms are important characteristic properties of the AM agent (Han, 2003). Antimicrobial activity can be achieved by adding AM agents to a packaging system during manufacturing or by using AM polymeric materials (Hotchkiss 1997). There are three typical systems of AM agent activity: (i) absorption; (ii) immobilisation; and (iii) release systems. The selection of an AM agent therefore depends primarily on its activity against the target microorganisms (Ahvenainen, 2003). In food packaging, migration is used to describe the transfer of a substance from the packaging material into a food (Choudhry et al., 1998).

REFERENCE

[1] Kolar M, Urbanek K, Latal T. Antibiotic selective pressure and development of bacterial resistance. Int J Antimicrob Ag.2001;17:357–363. | | [2] Moghimi SM. Nanomedicine: prospective diagnostic and therapeutic potential. Asia Pacific Biotech News. 2005;9:1072- 1077. | | [3] Gajjar P, Pettee B, Britt DW, Huang W, Johnson WP, Anderson J. Antimicrobial activities of commercial nanoparticlesagainst an environmental soil microbe, Pseudomonas putida KT2440. Journal of Biological Engineering. 2009;3:9-22. | | [4] Feynman R. There's plenty of room at the bottom. Science. 1991;254:1300-1301. | | [5] Parak WJ, Gerion D, Pellegrino T, Zanchet D, Micheel C, Williams CS, Boudreau R, Le Gros MA, Larabell CA, AlivisatosAP: Biological applications of colloidal nanocrystals. Nanotechnology. 2003;14:15-27. | | [6] Whitesides GM. The 'right' size in Nanobiotechnology. Nature Biotechnology. 2003; 21:1161-1165. | | [7] Gutierrez FM, Olive PL, Banuelos A, Orrantia E, Nino N, Sanchez EM, Ruiz F, Bach H, Gay YA. Synthesis,characterization, and evaluation of antimicrobial and cytotoxic effect of silver and titanium nanoparticles. Nanomedicine. 2010;6:681-688 | | [8] Ponce AA, Klabunde KJ. Chemical and catalytic activity of copper nanoparticles repared via metal vapor synthesis. J Mol Catal A 2005;225:1–6. | | [9] Huang Z, Cui F, Kang H, Chen J, Zhang X, Xia C. Highly dispersed silica-supported copper nanoparticles prepared by precipitation–gel method: a simple but efficient and stable catalyst for glycerol hydrogenolysis. Chem Mater 2008;20: 5090–9. | | [10] Dhas NA, Raj CP, Gedanken A. Synthesis, characterization, and properties of metallic copper nanoparticles. Chem Mater 1998;10:1446–52. | [11] Liu Z, Bando Y. A novel method for preparing copper nanorods and nanowires. Adv Mater 2003;15:303–5. | [12] Zhao Y, Zhu JJ, Hong JM, Bian N, Chen HY. Microwave-induced polyol-process synthesis of copper and copper oxide nanocrystals with controllable morphology. Eur J Inorg Chem 2004;20:4072–80. | [13] Yang M, Zhu JJ. Spherical hollow assembly composed of Cu2O nanoparticles. J Cryst Growth 2003;256:134–8. | [14] Yeh MS, Yang YS, Lee YP, Lee HF, Yeh YH, Yeh CS. Formation and characteristics of Cu colloids from CuO powder by laser irradiation in 2-propanol. J Phys Chem B 1999;103:6851–7. | [15] Grisaru H, Palchik O, Gedanken A, Palchik V, Slifkin MA, Weiss AM. Microwaveassisted polyol synthesis of CuInTe2 and CuInSe2 nanoparticles. Inorg Chem 2003;42:7148–55. | [16] Park BK, Jeong S, Kim D, Moon J, Lim S, Kim JS. Synthesis and size control of monodisperse copper nanoparticles by polyol method. J Colloid Interface Sci 2007;311: 417–24. | [17] Wei Y, Chen S, Kowalczyk B, Huda S, Gray TP, Grzybowski BA. Synthesis of stable, low-dispersity copper nanoparticles and nanorods and their antifungal and catalytic properties. J Phys Chem C 2010;114:15612–6. | [18] Morones JR, Elechiguerra JL, Camacho A, Holt K, Kouri JB, Ramírez JT, et al. The bactericidal effect of silver nanoparticles. Nanotechnology 2005;16:2346–53. | [19] Yoon K, Byeon JH, Park J, Hwang J. Susceptibility constants of Escherichia coli and Bacillus subtilis to silver and copper nanoparticles. Sci Total Environ 2007;373: 572–5.1 | [20] Appendini, P., Hotchkiss, J.H. 2002. "Review of Antimicrobial Food Packaging", Innovative Food Science & Emerging Technologies. Vol. 3, pp. 113.