Advanced green antibacterial materials made by mussel-inspired chemistry

Since ancient times, silver and its salts have universally been employed as antibacterial agents for the treatment of infections, burns and chronic wounds in curative and preventive health care, because of their extraordinary inhibitory and bactericidal properties for a broad spectrum of bacterial strains. While, after the identification of penicillin by Alexander Fleming, a large variety of organic antibiotics have been synthesized or discovered, which indeed revolutionized medicine

over the 20-th century. With the development of advanced synthetic technique, artificial antibiotics gradually seized the territory of silver-based antibacterial agents, whereas the recent prosperous of nanotechnology endue silver with a superior antibacterial performance when the size of silver was declined into a nanoscale, because silver nanoparticles exhibit enormously large surface area which facilitate their contact with bacteria, correspondingly increasing the antibacterial efficiency.

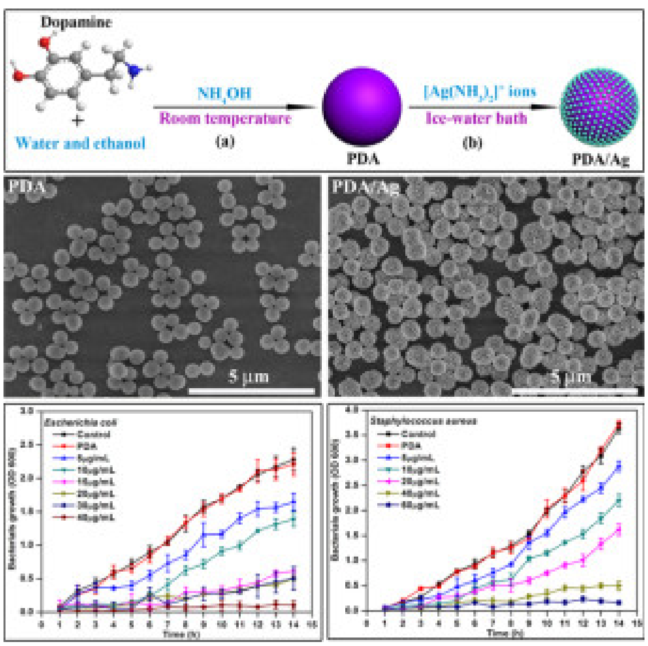

Fig.1. Schematic diagram illustrating the formation of PDA particles and PDA/Ag nanocomposite particles, scanning electron microscopy (SEM) images of PDA particles and PDA/Ag nanocomposite particles, and bacterial growth curves are employed to evaluate the antibacterial activities of the PDA/Ag nanocomposite particles against Escherichia coli and Staphylococcus aureus.

Apart from that, silver nanomaterials are more human- and animal-friendly than their counterparts, some artificial antibiotics are toxic to humans and animals, even when given in therapeutic dosage. One key problem to commercialize the use of silver nanoparticles is how keep silver stable, where is mainly ascribed to their high surface energy. To meet the increasing general practical demands for hygiene in public health care, various stable matrices have been employed to stabilize silver nanoparticles, yet without loss of their antibacterial activity. This endows old silver based antibacterial agents with new life.

In our research, we combine the use of mussel inspired chemistry (polydopamine) and silver nanoparticles to synthesize a novel composite effective antibacterial material. Inspired by the long-lasting adhesion in a wet environment by mussel in nature, we make use of an artificial chemical dopamine to achieve an analogous adhesive phenomenon. The monodisperse ‘sticky’ polydopamine (PDA) particles are first prepared by the oxidation and self-polymerization of dopamine in a slightly alkali aqueous environment at room temperature. Thanks to the abundant catechol and amine groups on the surface, PDA particles offer an ideal site for the in-situ secondary reaction. In our case, $[Ag(NH_3)_2]^+$ ions were introduced and subsequently in-situ reduced to metallic silver nanoparticles. The preparation process is green ranging from the reaction chemicals to products, which are proved by the cytotoxicity test against HEK293T human embryonic kidney cells. Whereas the products demonstrate enhanced antibacterial abilities against *Escherichia coli* (Gram-negative bacteria) and *Staphylococcus aureus* (Gram-positive bacteria), which, we believe, may also applicable to any other bacteria and virus with rational adaptions.

Publication

Bioinspired synthesis of polydopamine/Ag nanocomposite particles with antibacterial activities.
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