DISSERTATION INFORMATION

Title:: RESEARCH METHODOLODY OF SYNTHESIS THE ANTI-BACTERIAL MATERIALS Ag/$ZnTiO_3$ AND Ag/Zn_2TiO_4 AND IT'S APPLICABLE TO FABRICATE THE ANTI-BACTERIAL GLAZED TILES

Major: **Chemical Engineering**

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Objective of this dissertation:

A method of intermediate chelation is based on Sol-gel method synthesize $ZnTiO_3$, Zn_2TiO_4 and Ag/$ZnTiO_3$, Ag/Zn_2TiO_4 materials which have nanoscale. After synthesizing these antibacterial materials, their physical and chemical property and antibacterial activity are determined and It's applicable to fabricate the anti-bacterial glazed ceramic tiles.

Contributions of this dissertation:

This dissertation has achieved the following results:

- The $ZnTiO_3$ and Ag/$ZnTiO_3$ antibacterial nanomaterials with perovskite structure and Zn_2TiO_4 and Ag/Zn_2TiO_4 with spinel structure that exhibit the good antibacterial activity with or without the sunlight were synthesized successfully by the intermediate complex method based on sol-gel method. These materials are synthesized with the nanometer size and determined less than 50 nm through the scanning microscope (SEM) and transmission microscopy method (TEM). They are confirmed to have good antibaterial activity against both *S.aureus* and *E.coli* under sunlight or even in the dark by the dilution method and the count plate method. Furthermore, these materials exhibit good antibacterial properties in the aqua environment and even in the antibacterial ceramic tiles that are used in the hospital and the kitchen.

- The silver is doped with $ZnTiO_3$ and Zn_2TiO_4 to improve their antibacterial activity. Results obtained from XRD patterns and the curve fitting of XPS spectra revealed that silver metal and its oxides are presented in the synthesized powder. A small amount of silver nanoparticles in the material structure helps to reduce band gap energy, limits the recombination of electron and hole pairs, increases photocatalytic activity and improves antibacterial activity. In addition, the migration of silver and ion Ag^+ on the surface of antibacterial materials also helps their antibacterial activity more improve because silver and ion Ag^+ are strong antibacterial agents that can directly attack the cell membrane and kill bacteria. Therefore, the combination of silver with $ZnTiO_3$ and Zn_2TiO_4 to increase the antibacterial activity of these materials.
- The best conditions for the synthesis of the antibacterial materials are as follows: One of the new and prominent points of the dissetation is that changing the ratio between precursors and EDTA will create materials with peroskite structure or materials with spinel structure (with the ratio Zn^{2+}: Ti^{4+}: EDTA = 1:1:1, $ZnTiO_3$ and $Ag/ZnTiO_3$ are made, while with Zn^{2+}: Ti^{4+}: EDTA = 2:1:6, Zn_2TiO_4 and Ag/Zn_2TiO_4 are created). Thus, when the EDTA ratio increases by 6 times, the $ZnTiO_3$ nanomaterial with perovsite structure will turn into nanosized Zn_2TiO_4 with Zn_2TiO_4 spinel structure at 650°C temperature, much lower than previous studies of 950°C. The synthesis of the above materials with the following technological parameters: sol-making time: 4 hours, heating temperature: 650°C, pH: 4,5 and heating time: 2 hours (for $ZnTiO_3$ and $Ag/ZnTiO_3$), 1 hour (for Zn_2TiO_4 and Ag/Zn_2TiO_4) to synthesize the antibacterial materials with the nanometer size.
- The antibacterial ceramic tiles coated by the above materials are prepared successfully. Their antibacterial activity was proved by contacting method (with the Ag/Zn_2TiO_4 material of 2g/m^2 and the $Ag/ZnTiO_3$ material of 5g/m^2) with the sunlight or without the visible light. When the ceramic tiles are soaked in water for 72 hours, their antibacterial activities are still effective. Moreover, the surface durability of ceramic tiles coated with antibacterial materials is much better than the glazed tile.