

CHAPTER – IX

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Summary and Conclusion

Ionic liquid assisted synthesis of metal/metal oxide/bentonite nanocomposites by thermal decomposition method and this research works results and discussion are split up into five chapters. All the chapters are clearly discussed through effective microscopic and spectroscopic techniques. The antimicrobial activities and *in vitro* cytotoxicity of nanocomposites were also investigated. From this entire works, the conclusion is give below;

The facile synthesis of Mn_3O_4 /bentonite nanocomposites have been successfully synthesized by thermal decomposition. From the observation of XRD, FT-IR, SEM and TEM analyses observation confirmed the formation of manganese oxide nanoparticles into platelets of bentonite surface. Antimicrobial activity tests against different harmful pathogens, the synthesized nanocomposites shows good antimicrobial behaviour.

We have successfully synthesized Ag/TiO₂/bent nanocomposite using IL. This IL is effectively acts as a capping agent for the synthesis of novel nanocrystalline nanocomposite. The good crystalline and morphology of nanocomposite are responsible in major role of IL. In this research work; ILs has been provided a fast and environmentally friendly medium for crystallization of Ag/TiO₂/bent/IL nanocomposite. This study showed the Ag/TiO₂/bent/IL nanocomposite has potent antibacterial against Gram-positive and Gram-negative bacteria and cytotoxicity behaviour of HEK 293 cell line. Ag/CuO/bent nanocomposite with and without IL were synthesized by thermal decomposition method. After Ag/CuO modification, the formation of guest intercalation materials of Ag/CuO over the clay was observed by XRD, XPS, SEM, TEM, EDX and FT-IR results implied that intercalated nanoparticles can exist in mesopores of

bentonite composite, the results demonstrated the order of antibacterial and cytotoxicity activities of nanocomposite.

The novel Ag/ZnO/bent nanocomposites have successfully synthesized in the absence and presence of IL. The nanocomposites exhibit high crystalline and good mesoporous spherical morphology with the role of IL as a capping agent of guest materials. The Ag/ZnO/bent/IL nanocomposite shows high antibacterial activity against *S. aureus* and *E. coli* and good cytotoxicity behaviour with HEK 293 cell lines. Ag/Mn₃O₄/bent/IL nanocomposite was successfully synthesized using thermal decomposition method. The observation from SEM and TEM spectra confirmed the rod with spherical shape of intercalated materials covered into the host material of bentonite. The nanocomposite can be a promising antibacterial agent and also cytotoxicity behaviour. These synthesized novel nanocomposite materials are highly suitable for skin diseases applications with good biological performances.

List of Publications

1. **K. Bama** and M. Sundrarajan*, Facile synthesis and antimicrobial activity of manganese oxide/bentonite nanocomposite, *Research on Chemical Intermediates*, 43 (2017) 2351-2365. (I.F: 1.369)
2. **K. Bama** and M. Sundrarajan*, Synthesis and characterization of Mn₃O₄/BC nanocomposite and its antimicrobial activity, *Journal of Inorganic and Organometallic Polymers and Materials*, 27 (2017) 275-284. (I.F: 1.577)
3. **K. Bama** and M. Sundrarajan*, Ag/TiO₂/bentonite nanocomposite for biological applications: synthesis, characterization, antibacterial and cytotoxic investigations, *Advanced powder technology*, 28 (2017) 2265-2280. (I.F: 2.659)
4. **K. Bama** and M. Sundrarajan*, Improved Surface morphology of silver/copper oxide/bentonite nanocomposite using aliphatic ammonium based ionic liquid for enhanced biological activities, *Journal of Molecular Liquids*, 241 (2017)1044-1058. (I.F: 3.648)
5. M. Sundrarajan*, **K. Bama**, M. Bhavani, M. Jegatheeswaran, S. Ambika, A. Sangili, P. Nithya, R. Sumathi, Obtaining titanium dioxide nanoparticles with spherical shape and antimicrobial properties using *M. Citrifolia* leaves extract by hydrothermal method, *Journal of Photochemistry and Photobiology B: Biology*, 17 (2017) 117-124. (I.F: 2.909)

List of communications

1. M. Sundrarajan*, **K. Bama**, G. Selvanathan and M. Ramesh prabhu, Ionic liquid mediated: Enhanced surface morphology of silver/manganese oxide/bentonite nanocomposite for improved biological activities, Journal of molecular liquid (Paper status: Minor Revision) (I.F: 3.648).
2. **K. Bama**, S. Jegatheeswaran, S. Ambika, A. Sangili, D. Govindaraj and M. Sundrarajan*, Enhanced surface morphology and biological activities of Ag/ZnO/bentonite nanocomposites with and without addition of aliphatic ionic liquid, Advanced Powder Technology (Paper status: Under review) (I.F: 2.909).

List of National/International conferences

1. **K. Bama**, K. Ramanujam, S. Jegatheeswaran, S. Ambika, M. Balaji and M. Sundrarajan*, Synthesis: Intercalation of normal spinal Mn_3O_4 into sodium bentonite material and their biological application, (FACTs - 2015), Department of Industrial Chemistry, Alagappa University, Karaikudi on 6 & 8th Mar 2015.
2. **K. Bama**, S. Jegatheeswaran, S. Ambika, M. Balaji, A. Sangili, P. Nithya and M. Sundrarajan*, CuO/bentonite based nanostructure for enhanced biological applications, International conference on chemical and environmental research, Jamal Mohammed college, Trichy on 7 & 8th - Jan 2017.
3. **K. Bama**, M.Sundrarajan* and K. Bharathi, Enhanced antibacterial activity and low band gap energy of ZnO/BC nanocomposite material, (FACTs - 2016), Department of Industrial Chemistry, Alagappa University, Karaikudi on 21 & 23th - Mar 2016.
4. **K. Bama**, S. Jegatheeswaran, S. Ambika, M. Balaji, A. Sangili and M. Sundrarajan*, Intercalation of ferric oxide treated bentonite: Evaluation of its antibiotic application, National Seminar on Recent trends in Organic Synthesis and Chemical Biology, Department of Chemistry, Annamalai University on 9 & 10th - Oct 2015.
5. **K. Bama**, S. Jegatheeswaran, S. Ambika, M. Balaji, A. Sangili and M. Sundrarajan*, Antifungal activity of ferric oxide intercalated into bentonite clay nanocomposite, International conference on chemical and environmental research, Jamal Mohammed college on Trichy, 17th - Dec 2016.
6. K. Iswarya, **K. Bama**, J. Anandha raj and M. Sundrarajan*, Ag nanoparticles from *Nyctanthes arbor-tristis*- Synthesis, characterization and applications, (FACTs - 2016), Department of Industrial Chemistry, Alagappa University, Karaikudi on 21-23th - Mar 2016.

7. M. Bhavani, **K. Bama**, S. Jegatheeswaran, S. Ambika, M. Balaji, A. Sangili, P. Nithya, R. Sumathi, and M. Sundrarajan*, Green synthesis of quasi-spherical shape of titanium dioxide nanoparticles using hydrothermal method, Biomaterials in Medicinal Chemistry, Madurai Kamaraj University, Madurai on 12-13th - Apr 2017.
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9. S. Jegatheeswaran, M. Sundrarajan*, S. Selvam, K. Ramanujam, S. Ambika, **K. Bama**, M. Balaji and V. Maheshkumar, Ionic liquid network as a tool to graft silver nanoparticles on hydroxyapatite nanosticks and its bactericidal effect , (FACTs - 2015), Department of Industrial Chemistry, Alagappa University, Karaikudi on 6 & 7th Mar 2015.
10. S. Ambika, M. Sundrarajan*, K. Ramanujam, S. Jegatheeswaran, **K. Bama** and M. Balaji, Green synthesis of TiO₂ nanoparticles using tritax procumbens leaf extract and their antibacterial activity, (FACTs - 2015), Department of Industrial Chemistry, Alagappa University, Karaikudi on 6 & 7th Mar 2015.
11. K. Ramanujam, S. Jegatheeswaran, S. Ambika, **K. Bama**, M. Balaji and M. Sundrarajan*, Biosynthesis, characterization and antibacterial effect of fruits mediated TiO₂ nanoparticles using Emblica Officinalis, NOCCR - 2014, PG and Research Department of Chemistry, A.V.V.M. Sri pushpam college, Poondi, Thanjavur on 29 & 30th Dec 2014.
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antibacterial activity, Advancements in polymeric materials in Indian institute of science, Bangalore on 20 & 22th Feb 2015.

13. S. Jegatheeswaran, S. Selvam, **K. Bama**, M. Balaji and M. Sundrarajan*, A simple sol gel technique for synthesis of hydroxyapatite/ silver nanocomposites in the ionic liquid media and its antibacterial efficacy, NOCCR - 2014, PG and Research Department of Chemistry, A.V.V.M. Sri pushpam college, Poondi, Thanjavur on 29 & 30th - Dec 2014.

14. S. Ambika, M. Thiru selvi, S. Jegatheeshwaran, **K. Bama**, M. Balaji, A. Sangili and M. Sundrarajan*, Synthesis of nano-crystalline ZnO by greener method and their antibacterial activity, National Seminar on Recent trends in Organic Synthesis and Chemical Biology, Department of Chemistry, Annamalai University, 9 & 10th - Oct 2015.

15. K. Ramanujam, S. Jegatheeswaran, S. Ambika, **K. Bama**, M. Balaji and M. Sundrarajan*, Synthesis of pomegranate peel extract mediated SnO₂ nanoparticles for enhanced bactericidal activity , (FACTs - 2015), Department of Industrial Chemistry, Alagappa University, Karaikudi on 6 & 7th - Mar 2015.

16. S. Arockiya Gowri, M. Balaji, M. Sundrarajan*, K. Ramanujam, S. Jegatheeswaran, S. Ambika, **K. Bama** and R. Jayamani, Development of low cost Pt free palladium sulfide/multiwall carbon nanotubes hybrid nanocomposites counter electrode for high efficiency dye sensitized solar cell , (FACTs - 2015), Department of Industrial Chemistry, Alagappa University, Karaikudi on 6 & 7th - Mar 2015.

17. S. Ambika, K.Ramanujam, S. Jegatheeswaran, **K. Bama** and M.Sundrarajan*, Biosynthesis and characterization of ZnO nanoparticles using solanum Trilobatum and their protein study , National seminar on New opportunitites and challenges in chemcial research (NOCCR - 2014),

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