Dr. Sanjay R. Dhage

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Qualification

Ph.D. (2001-2005) Materials chemistry from National Chemical Laboratory (CSIR-NCL) Pune
M.Sc. (1998-2000) Inorganic Chemistry from University of Pune
B.Sc. (1994-1997) MPC from Nagpur University

Professional experience

2016 - Till date	*Scientist E* International advanced Research Center for Power Metallurgy and New Materials (ARCI) PO Balapur, Hyderabad - 500005
2011 - 2016	*Scientist D* International advanced Research Center for Power Metallurgy and New Materials (ARCI) PO Balapur, Hyderabad - 500005
2010 - 2011	*Scientist on contract* International advanced Research Center for Power Metallurgy and New Materials (ARCI) PO Balapur, Hyderabad - 500005
2008 - 2010	*Postdoctoral Researcher* University of California Los Angeles, USA
2006 - 2008	*Postdoctoral Researcher* Chonbuk National University, South Korea
2005 – 2006	*Research Associate* Corporate R&D Center, Bharat Petroleum Corp. Ltd. Noida, India

Areas of Research Interest

Solar energy materials. Thin film solar cells. Solar photovoltaic device development. CIGS thin film based solar cell – Pilot scale fabrication and device development. CIGS thin films by sputtering and selenization/sulfurization. Non-vacuum route for CIGS thin films. Ink-jet printing of CIGS. Novel processing for thin film applications. Metal thin films by sputtering. Transparent conducting oxide (TCO) thin films by sputtering. Performance testing of solar devices.

Projects

1. Pilot scale development of CIGS thin film solar cells by two step process, sputtering and selenization on glass substrate size of 300 mm x 300 mm.
2. Thin film absorber material and processing (Sponsored: SERIIUS-JCERDC, 2012-2017. Rs. 292.5 Lakh (shared cost)
3. Nanoink based CIGS solar cells for building integrated PV (BIPV) application. (Sponsored: DST-Technology Research Center, 2016-2021)

Achievements/awards/affiliation

Achievements and awards:

1. Industrial postdoc fellowship, BPCL India (January 2006)
2. Brain Korea 21 postdoctoral fellowship, Chonbuk National University, South Korea (September 2006)
3. University postdoctoral fellowship, University of California Los Angeles, USA (February 2008)
4. Publications in peer-reviewed international journals: 60 (All-together citations- 1415, *h* index -20, h10 index – 35 Source: www.scopus.com)

Top 25 most downloaded articles within the journal:

1. **Sanjay R. Dhage,** Vandana D. Choube, Violet Samuel and V. Ravi, Synthesis of nanocrystalline TiO_2 at 100°C, *Mater. Lett.* 58 (17-18) 2310 (2004)
   July-September 2004
2. Violet Samuel, P. Muthukumar S.P. Gaikwad, **S.R. Dhage,** and V. Ravi, Synthesis of mesoporous rutile TiO_2, *Mater. Lett.* 58 (20) 2514 (2004)
   July-September 2004
3. **S.R. Dhage,** Y.B. Khollam, S.B. Dhespande, H.S. Potdar and V. Ravi, Synthesis of bismuth titanate by citrate method, *Mater. Res. Bull.* 39 (13) 1993 (2004)
   October-December 2004
4. **S.R. Dhage** and H. Thomas Hahn, Rapid treatment of CIGS particles by intense pulsed light, *J. Phys. Chem. Solids* 71 (2010) 1480
   July-September 2010, October-December 2010

Affiliation to Professional societies:

1. Materials Research Society of India
2. Solar Energy Society of India

Editorial board member of Journals:

1. SCIRES Journal of Energy
2. Recent Advancement in Physics and Astronomy
3. International Journal of Innovative Research and Review
4. Dataset Papers in Science

Regular reviewer of Journals:

1. Solar Energy Materials and Solar cells. 2. Solar Energy. 3. Advanced Energy Materials. 4. Advanced Engineering Materials. 5. Thin Solid Films. 6. Materials Chemistry and Physics. 7. Journal of Alloys and compounds. 8. Superlattice and Microstructures. 9. Journal of Solid State Chemistry. 10. Journal of colloid and interface science. 11. Synthetic metals. 12. Composite science and technology. 13. Journal of composite materials. 14. ACS Applied Materials and Interphases. 15. Nanoscale Research Letters. 16. Review of scientific instruments. 17. Journal of Nanoparticles Research. 18. Scientific Reports.

Thesis supervision

Ph. D thesis: **2 (ongoing)**
M. Tech. thesis: **6**
M.Sc./B. Tech. Projects: **8**

Publications/Proceedings

1. Role of selenium content in selenization of inkjet printed $CIGSe_2$ thin film solar cell Brijesh Singh Yadav, Suhash Ranjan Dey and **Sanjay R. Dhage***, *AIP proceedings* AIP Conf. Proc. 2082, 050001 (DOI:10.1063/1.5093861)
2. Effective ink jet printing of aqueous ink for Cu (In, Ga) Se_2 thin film absorber for solar cell application. Brijesh Singh Yadav, Suhash R Dey, and **Sanjay R. Dhage*** *Solar Energy179 (2019) 363-370*
3. Transparent conducting Al:ZnO thin film on large area by efficient cylindrical rotating DC magnetron sputtering. **Sanjay R. Dhage*** and Amol C. Badgujar, *Journal of Alloys and Compounds* Vol 763, (2018) 504 (DOI: 10.1016/j.jallcom.2018.05.234)
4. Molybdenum bilayer thin film on large area by cylindrical rotating DC magnetron sputtering for CIGS solar cell application, Amol C. Badgujar, Brijesh singh Yadav, Suhash R Dey, Rajiv O. Dusane and **Sanjay R. Dhage*** *Proceedings of 35th EUPVSEC 2018 (DOI: 10.4229/35thEUPVSEC20182018-3BV2.9*)
5. Process parameter impact on selective laser ablation of bilayer Molybdenum thin films for CIGS solar cell applications, Amol C. Badgujar, Shrikant V. Joshi and **Sanjay R. Dhage***, *Materials Focus* 7 (2018) 1-7 *(DOI: 10.1166/mat.2018.1054)*
6. Cu(In,Ga)Se2 thin film absorber layer by flash light post-treatment, Amol C. Badgujar, Rajiv O. Dusane and **Sanjay R. Dhage***, *Vacuum 153 (2018) 191-194 (DOI: 10.1016/j.vacuum.2018.04.021)*
7. Sonochemical synthesis of CuIn0.7Ga0.3Se2 nanoparticles for thin film absorber application, and Amol C. Badgujar, Rajiv O. Dusane and **Sanjay R. Dhage*** *Materials Science in Semiconductor Processing* 81 (2018) 17-21
8. Chalcopyrite CIGS absorber layer by inkjet printing for photovoltaic application, Brijesh Singh Yadav, Suhash R Day and **Sanjay R. Dhage***, *Materials Today: Proceedings* 4 (2017) 12480-12483
9. CdS buffer layer by CBD on 300 mm x 300 mm glass for CIGS solar cell application, P. Uday Bhaskar and **Sanjay R. Dhage***, *Materials Today: Proceedings* 4 (2017) 12525-12528
10. Effect of various surface treatments on adhesion strength of magnetron sputtered bi-layer molybdenum thin films on soda lime glass substrate, B.S.Yadav, Amol C. Badgujar and **Sanjay R. Dhage***, *Solar Energy* 157 (2017) 507-513

11. Non-vacuum route for CIGS thin film absorber on flexible glass substrates, Amol C. Badgujar, Madhuri Kukkadapu, Sean Garner[+], **Sanjay R. Dhage***, and Shrikant V. Joshi, *Proceedings of 42nd IEEE Photovoltaic Specialist Conference 2015* DOI: 10.1109/PVSC.2015.7356105
12. Process parameter impact on properties of sputtered large-area Mo bilayers for CIGS thin film solar cell applications, Amol C. Badgujar, **Sanjay R. Dhage***, and Shrikant V. Joshi, *Thin Solid films* 589 (2015) 79-84
13. Fabrication of CIGS thin film absorber by laser treatment of pre-deposited nano-ink precursor layer, **Sanjay R. Dhage***, Manish Tak and Shrikant V. Joshi, *Materials Letter* 134 (2014) 302
14. CIGS absorber layer by single-step non-vacuum intense pulsed light treatment of inkjet-printed film, **Sanjay R. Dhage***, P.S. Chandrasekhar, S.B. Chandrasekhar and Shrikant V. Joshi, *Proceedings of 40th IEEE Photovoltaic Specialist Conference* (2014) 1607-1610
15. Photoluminescence properties of thermally stable highly crystalline CdS nanoparticles, **S.R. Dhage***, H.A. Colorado and H. Thomas Hahn, *Materials Research* 16 (2) (2013) 504
16. Intense pulsed light sintering technique for nanomaterials, H.A. Colorado, **S.R. Dhage**, J. M. Yang and H. Thomas Hahn, *TMS annual meeting* 1 (2012) 577
17. Thermo chemical stability of CdS nanoparticles under intense pulsed light irradiation and high temperature condition, H.A. Colorado, **S.R. Dhage**, and H. Thomas Hahn, *Materials Science and Engineering B* 176 (15) (2011) 1161
18. Morphological variations in CdS nanocrystals without phase transformation, **S.R. Dhage***, H.A. Colorado and H. Thomas Hahn, *Nanoscale Research Letters* 40 (2011) 122
19. CIGS Thin Film Preparation from CIG Metallic Alloy and Se Nanoparticles by Intense Pulsed Light Technique, **S.R. Dhage***, Hak-Sung Kim and H. Thomas Hahn, *Journal of Electronic Materials* 40 (2011) 122
20. Rapid treatment of CIGS particles by intense pulsed light, **S.R. Dhage***, and H. Thomas Hahn, *Journal of Physics and Chemistry of Solids* 71 (2010) 1480
21. Polypyrrole/silicon carbide nanocomposites with tunable electrical conductivity, P. Mavinakuli, S. Wei Q. Wang, A.B. Karki, **S. Dhage**, Z. Wang, D.P. Young, Z. Guo, *Journal of physical Chemistry C* 114 (2010) 3874
22. A simulation study on the direct carbothermal reduction of SiO_2 for Si metal, Hyun-Cheol Lee, **Sanjay Dhage,** M. Shaheer Akhtar, Do Hwan Kwak, Woo Jin Lee, Chong-Yeal Kim, O-Bong Yang, *Current Applied Physics* 10 (2010) S21
23. Intense pulsed light sintering of copper nano ink for printed electronic technique, Hak-Sung Kim, **Sanjay R. Dhage,** Dong-Eun Shim and H. Thomas Hahn, *Applied physics A* 97 (2009) 791
24. Design of optimization of CIGS thin film solar cell using numerical and design of experimental approach, Ill-Woo Seok, **Sanjay Dhage,** H. Kim and H. T. Hahn, *Proceedings of the ASME 3rd International Conference on Energy Sustainability 2009, ES2009* 1, pp. 999-1003
25. Nanocomposites for power laminates, H. S. Kim, Y. M. Lee, **S. Dhage,** J. S. Kang and H. T. Hahn, *Proceedings of the International Conference on Composited Materials (ICCM17)* 2009, Edniberg UK
26. Low temperature fabrication of hexagon shaped h-MoO_3 nanorods and its phase transformation, **S.R. Dhage***, M. S. Hassan and O.B. Yang, *Materials Chemistry and Physics* 14 (2009) 511
27. Formation of SiC nanowhiskers by carbothermic reduction of silica with activated carbon, **S.R. Dhage,** H.C. Lee, M.S. Hassan. M.S. Akthar, C.Y. Kim, J. M. Sohn, H.S. Shin and O.B. Yang, *Materials Letters* 63 (2009) 174
28. Varistor property of SnO_2.CoO.Ta_2O_5 ceramic modified by barium and strontium, **S.R. Dhage***, V. Ravi and O.B. Yang, *Journal of Alloys and Compounds* 466 (2008) 483
29. Low voltage varistor ceramics based on SnO_2, **S.R. Dhage***, V. Ravi and O.B. Yang, *Bulletin of Materials Science* 30 (2007) 583
30. The influence of surfactant on ZnO Varistor, **S.R. Dhage**, S.C. Navale and V. Ravi, *Ceramic International* 33 (2007) 289
31. Studies on SnO_2-ZrO_2 solid solution, **S. R. Dhage**, Violet Samuel, Renu Pasricha and V. Ravi, *Ceramic International* 32 (2006) 939

32. A co-precipitation technique for the preparation of ferroelectric $BaBi_2Ta_2O_9$, **S.R. Dhage**, R. Pasricha, A.V. Murugan and V. Ravi, *Materials Chemistry and Physics* 98 (2006) 344
33. Synthesis of bismuth oxide nanoparticles at 100 °C, M.M. Patil, V.V. Deshpande, **S.R. Dhage** and V. Ravi, *Materials Letters* 59 (2005) 2523
34. Preparation of ferroelectric $BaNb_2O_6$ by the urea method, **S.R. Dhage,** R. Pasricha and V. Ravi, *Materials Letters* 59 (2005) 1929
35. Co-precipitation method for the preparation of ferroelectric $CaBi_4Ti_4O_{15}$, S.P. Gaikwad, **S.R. Dhage** and V. Ravi, *Journal of Materials Science: Materials in Electronics* 16 (2005) 229
36. Synthesis of $Sr_{0.5}Ba_{0.5}Nb_2O_6$ by urea method, **S.R. Dhage,** Renu Pasricha and V. Ravi, *Materials Letters* 59 (2005) 1053
37. Synthesis of fine particles of ZnO at 100 °C, **S.R. Dhage,** Renu Pasricha and V. Ravi, *Materials Letters* 59 (2005) 779
38. Synthesis of bismuth titanate by the urea method, M. Anilkumar, **S.R. Dhage** and V. Ravi, *Materials Letters* 59 (2005) 514
39. Synthesis of $Ce_{0.75}Zr_{0.25}O_2$ at 100 °C, **S.R. Dhage,** S.P. Gaikwad, P. Muthukumar and V. Ravi, *Ceramic International* 31 (2005) 211
40. Co-precipitation method for the preparation of nanocrystalline ferroelectric $SrBi_2Nb_2O_9$ ceramics, S.P. Gaikwad, **S.R. Dhage,** H.S. Potdar, V. Samuel and V. Ravi, *Journal of Electroceramics* 14 (2005) 83
41. Synthesis of nanocrystalline TiO_2 by tartarate gel method, **S.R. Dhage,** S.P. Gaikwad and V.Ravi, *Bulletin of Materials Science* 27 (2004) 487
42. Synthesis of bismuth titanate by citrate method, **S.R. Dhage,** Y.B. Khollam, S.B. Dhespande, H.S. Potdar and V. Ravi, *Materials Research Bulletin* 39 (2004) 1993
43. Synthesis of mesoporous rutile TiO_2, Violet Samuel, P. Muthukumar S.P. Gaikwad, **S.R. Dhage,** and V. Ravi, *Materials Letters* 58 (2004) 2514
44. Synthesis of $Ce_{0.75}Zr_{0.25}O_2$ by citrate gel method, **S.R. Dhage,** S.P. Gaikwad, P. Muthukumar and V. Ravi, *Materials Letters* 58 (2004) 2704
45. Nonlinear I-V characteristics of doped SnO_2, **S. R. Dhage**, V.D. Choube and V. Ravi, *Materials Science and Engineering B* 110 (2004) 168
46. Synthesis of nanocrystalline TiO_2 at 100 °C, **Sanjay R. Dhage,** Vandana D. Choube, Violet Samuel and V. Ravi, *Materials Letters* 58 (2004) 2310
47. Synthesis of nanocrystalline SnO_2 powder at 100°C, **S.R. Dhage,** S.P. Gaikwad, Violet Samuel and V. Ravi, *Bulletin of Materials Science* 27 (2004) 221
48. Nonlinear I-V characteristics study of doped SnO_2, **S. R. Dhage** and V. Ravi and S.K. Date, *Bulletin of Materials Science* 27 (2004) 43
49. Influence of various donors on nonlinear I-V characteristics of tin dioxide ceramics, **S. R. Dhage** and V. Ravi, *Applied Physics Letters* 83 (2003) 4539
50. Synthesis of ultrafine TiO_2 by citrate gel method, **S. R. Dhage,** Renu Pasricha and V. Ravi, *Materials Research Bulletin* 38 (2003) 1623
51. Co-precipitation technique for the preparation of nanocrystalline ferroelectric $SrBi_2Ta_2O_9$, **S. R. Dhage,** Y. B. Khollam, S. B. Deshpande and V. Ravi, *Materials Research Bulletin* 38 (2003) 1601
52. Varistors based on doped SnO_2, **Sanjay R. Dhage,** Violet Samuel and V. Ravi, *Journal of Electroceramics* 11 (2003) 81
53. Preparation of microwave dielectric, $Sn_{0.2}Zr_{0.8}TiO_4$, **Sanjay R. Dhage,** V. Ravi and S.K. Date, *Bulletin of Materials Science* 26 (2003) 215
54. Effect of variation of molar ratio (pH) on the crystallization of iron oxide phases in microwave hydrothermal synthesis, **S. R. Dhage,** Y. B.Khollam H. S.Potdar, S. B.Deshpande, P. P.Bakare, S. R.Sainkar, and S. K. Date, *Materials Letters* 57 (2002) 457

55. Influence of lanthanum on the nonlinear I-V characteristics of SnO_2: Co, Nb, **Sanjay R. Dhage,** V. Ravi and S.K. Date, *Materials Letters* 57 (2002) 727
56. Chemical co-precipitation of mixed (Pb+Ti) oxalates precursor for the synthesis of $PbTiO_3$ powders, **S. R. Dhage,** Y. B. Khollam, H. S. Potdar, S. B. Deshpande, B. D. Sarwade, and S. K. Date, *Materials Letters* 56 (2002) 564
57. Microwave hydrothermal preparation of submicron-sized spherical magnetite (Fe_3O_4) powders, Y.B. Khollam, **S.R. Dhage,** H.S. Potdar, S.B. Deshpande, P.P. Bakare, S.D. Kulkarni, and S.K. Date, *Materials Letters* 56 (2002) 571

Patent

Title: Improved method of manufacturing copper-indium-gallium diselenide thin films by laser treatment. Patent application No: 2084/DEL/2212, Date: 05/07/2012
Inventors: Sanjay R. Dhage, Manish Tak and Shrikant V. Joshi

Invited talks/presentations

1. Thin film solar cells (invited talk) *One-week interdisciplinary AICTE QIP FDP on 'Solar Energy Harvensting" March 27-31, 2018* at Shri Guru Gobind Singhaji Institute of Engineering and Technology, Nanded 431606
2. *Solar Energy: Thin Film Solar Cells* (invited talk) January 32, 2018, Milind College of Science, Aurangabad 431001
3. Pulsed nanosecond laser scribing of bilayer Molybdenum back contact for CIGS thin film solar cell application, (Oral Presentation) *International Conference on Application of Lasers in Manufacturing September 9-11, 2015, New Delhi*
4. ARCI's research and technology demonstration initiatives for sole energy applications (Invited talk), *Research directions in Solar Energy-2014, April 1-2, 2014, Indian Institute of Science, Bangalore*
5. Environmentally Benign, Low-Cost Manufacturing of CIGS Thin Film based Solar Cells for Power Laminate application (Invited talk), *January 23 2010, ARCI, PO Balapur Hyderabad-500005*
6. Solar Cells: Future Energy for Environment (Invited talk), *15 January 2010, Arts Science and Commerce College Chandrapur, Maharashtra*
7. Review: Preparation of solar grade Silicon, (Invited talk) *May 11, 2007, New and Renewable Energy Materials Development Center (NewREC), Chonbuk National University South Korea.*
8. Environmentally benign low cost manufacturing of CIGS thin film base solar cells, (Oral presentation) *Annual Technology Conference, The 19th Korean-American scientist and engineer's association south west region University of California Irvine, USA February 2009*
9. Co-precipitation technique for the preparation of nanocrystalline ferroelectric $SrBi_2Nb_2O_9$ (Oral presentation) *Solid State Physics Symposium Guru Nanak Dev University, Amritsar India, December 2004*
10. S.R. Dhage and V. Ravi, Non-linear current-voltage characteristics of SnO_2 varistor (Oral presentation), *National seminar on Engineering Trends in Materials for Electrical Electronic and Magnetic Application,* Pune India, *November 2003*