

Ratyakshi, PhD

Female, 40

Scopus Author Id: 55808355900; ORCID ID:0000-0001-5617-5801 WOS Researcher ID: GNW-6815-2022

RESEARCH INTERESTS

Polymer nanocomposites, Reinforced composite fibers, Photocatalysis of hybrid nanostructures, Green synthesis of silver nanoparticles, ZnO nanostructures, Mesoporous silica

CAREER PROFILE

Institute	Designation	From	To	Duration	Nature
Bhaskaracharya College of Applied Sciences, University of Delhi, Delhi	Assistant Professor (Adhoc)	21 st July, 2015	Till date	10 years	Teaching & Research
IIT- Delhi, India	MHRD Research Fellow	2 nd Jan., 2010	19 th July, 2015	5 years & 7 months	Research
Electronic Science Department, Kurukshetra University, Kurukshetra	Teaching Associate	25 th Aug., 2009	1 st Jan., 2010	6 Months	Teaching

EDUCATIONAL QUALIFICATION

Degree	Institution	University/Board	Session	%age	Remarks
Ph. D. (Biocomposites)	IIT Delhi, India	IIT Delhi, India	2010-16	10 CGPA	Received Distinction from IIT Delhi
M. Tech. (Nanotechnology)	NIT Kurukshetra, India	NIT Kurukshetra, India	2007-09	9.828 CGPA (=88.45%)	Gold Medalist
M. Sc. (Biotechnology)	Department of Biotechnology	Kurukshetra University, Kurukshetra	2005-07	76.00%	Gold Medalist
B. Sc. (Biotechnology)	D. A. V. College, Karnal	Kurukshetra University, Kurukshetra	2002-05	83.50%	College Topper
Sr. Secondary (Medical)	Gita Niketan Res. Sr. Sec. School, Kurukshetra	C. B. S. E.	2001-02	84.00%	-
Matriculation	Gita Niketan Res. Sr. Sec. School, Kurukshetra	C. B. S. E.	1999-00	77.40%	-

RESEARCH PROJECTS

Title	Sponsor	My Role	Duration	Amount
Development of Novel Eco-Friendly Printable Packaging films for Industrial applications	University of Delhi	Co-PI	31 August 2015 to 30 September 2016	INR 5,00,000

PATENTS PUBLISHED

- US20180305543A1,
Country – United States
Publication Date - 25 October 2018
Pub . No . : US 2018 / 0305543 A1
- WO2017068603A1, Filing Date – 20 October 2016;
Publication Date - 27 April 2017

PATENTS GRANTED

- Country – India, Patent No – 350635,
Patent Certificate Serial No – 011128141, Grant Date – 02 November 2020
Title - Composite fibers having aligned Inorganic nano structures of high aspect ratio and preparation method
Inventors - Ashwini Kumar Agrawal, Manjeet Jassal, **Ratyakshi Nain**, Amol Gorakh Thite, Suchismita Bhabani,
Kiran Yadav, Applicant – IIT Delhi

RESEARCH PAPERS PUBLISHED

1. Ratyakshi Nain, Dharendra Singh, Manjeet Jassal[✉] and Ashwini K. Agrawal[✉] (2016). Zinc oxide nanorod assisted rapid single-step process for conversion of electrospun poly(acrylonitrile) nanofibers to carbon nanofibers with high graphitic content. *Nanoscale*, 8, 4360-4372. DOI 10.1039/C5NR06809F (*Royal Society of Chemistry Publication*) (SCI and Scopus Indexed Journal with an Impact Factor of 5.8). UGC indexed (Sr. no - 26783). ISSN: 2040-3364, E-ISSN: 2040-3372
2. Ratyakshi Nain, Kiran Yadav, Manjeet Jassal[✉], and Ashwini K. Agrawal[✉] (2015). Aligned ZnO nanorods as effective reinforcing material for obtaining high performance polyamide fibers. *Composites Science and Technology*, 120, 58-65. DOI: 10.1016/j.compscitech.2015.10.012 (*Elsevier Publication*) (SCI and Scopus Indexed Journal with an Impact factor of 8.3). UGC indexed (Sr. no - 8200). ISSN: 0266-3538
3. Sidhharth Sirohi, Dharendra Singh, Ratyakshi Nain, Dambarudhar Parida, Ashwini K. Agrawal[✉] and Manjeet Jassal[✉] (2015). Electrospun Composite Nanofibres of PVA Loaded with Nanoencapsulated n-Octadecane, *RSC Advances*, 5, 34377-34382, DOI: 10.1039/C4RA16988C (*Royal Society of Chemistry Publication*) (SCI and Scopus Indexed Journal with an Impact factor of 3.9). UGC indexed (Sr. no - 33062). E-ISSN: 2049-2069
4. Ratyakshi Nain, Manjeet Jassal[✉] and Ashwini K. Agrawal[✉] (2013). Polymeric nanofiber composites with aligned ZnO nanorods, *Composites Science and Technology*, Vol. 86, Pages 9–17. DOI: 10.1016/j.compscitech.2013.06.017 (*Elsevier Publication*) (SCI and Scopus Indexed Journal with an Impact factor of 8.3). UGC indexed (Sr. no - 8200). ISSN: 0266-3538 E-ISSN: 1879-1050
5. Kiran Yadav, Ratyakshi Nain, Manjeet Jassal[✉], and Ashwini K. Agrawal (2019). Free Standing Flexible Conductive PVA Nanoweb with Well Aligned Silver Nanowires. *Composites Science and Technology*, Vol. 182, Pages 1-8 DOI: 10.1016/j.compscitech.2019.107766 (*Elsevier Publication*) (SCI and Scopus Indexed Journal with an Impact factor of 8.3). UGC indexed (Sr. no - 8200). ISSN: 0266-3538
6. Sidhharth Sirohi, Avneesh Mittal, Ratyakshi Nain[✉], Nishant Jain, Ravinder Singh, Saiyam Dobhal, Balaram Pani, Dambarudhar Parida (2019). Effect of Nanoparticles Shape on Conductivity of Ag nanoparticle PVA composite films. *Polymer International* Vol. 68, Issue 12, Pages 1961-1967, DOI: 10.1002/pi.5906 (*Wiley Publication*) (SCI and Scopus Indexed Journal with an Impact factor of 3.213). ISSN: 0959-8103 E-ISSN: 1097-0126.
7. Shivani Singh Surah, Manoj Vishwakarma, Ritesh Kumar, Ratyakshi Nain, Sidhharth Sirohi, Gulshan Kumar (2019) Tuning the electronic band alignment properties of TiO₂ nanotubes by boron doping. *Results in Physics*, 12, Pages 1725-1731, DOI: 10.1016/j.rinp.2019.01.081 (*Elsevier Publication*) (SCI and Scopus Indexed Journal with an Impact factor of 4.4) ISSN: 2211-3797.
8. Ratyakshi Nain, Saiyam Dobhal, Parth Bidaliya, Gajender Saini, Balaram Pani and Sidhharth Sirohi (2018). Ag decorated silica nanostructures for surface plasmon enhanced photocatalysis. *RSC Advances*, Vol. 8 Issue 36, Pages 20287-20294, DOI: 10.1039/C8RA02543F (*Royal Society of Chemistry Publication*) (SCI and Scopus Indexed Journal with an Impact factor of 3.9). UGC indexed (Sr. no - 33062). ISSN: 2049-2069
9. Sidhharth Sirohi, Saiyam Dobhal, Manav Doshi, Ratyakshi Nain[✉], Krishna Dutt, and Balaram Pani (2018). Eco-friendly synthesis of PET-based polymeric plasticiser and its application in nitrile-PVC rubber blends. *Indian Chemical Engineer*, 1-12. DOI: 10.1080/00194506.2018.1529635. (*Taylor and Francis*) (ESCI and Scopus Indexed). ISSN: 0019-4506, EISSN: 0975-007X
10. Sidhharth Sirohi[✉], Ravinder Singh, Nishant Jain, Balaram Pani, Krishna Dutt, Ratyakshi Nain[✉] (2017). Synthesis and characterization of multifunctional ZnO/polyester green composite films. *Journal of Polymer Research*, 24(11), 193. Page 1-10. DOI: 10.1007/s10965-017-1355-8 (Springer Publication) (SCIE and Scopus Indexed Journal with an Impact Factor of 2.6). UGC Indexed (Sr. No. -19297). ISSN:1022-9760 (Print) EISSN:1572-8935
11. Sidhharth Sirohi, Anandpreet Singh, Chakit Dagar, Gajender Saini, Balaram Pani[✉] and Ratyakshi Nain[✉] (2017). Facile synthesis of microporous SiO₂/triangular Ag composite nanostructures for photocatalysis. *Applied Nanoscience*, 1-11. doi:10.1007/s13204-017-0597-4 (Springer Publication) (SCIE and Scopus Indexed Journal with an Impact Factor of 3.869). UGC indexed (Sr. No. - 49144). ISSN: 2190-5509
12. Nishant Jain, Ravinder Singh, Gulshan Kumar, Balaram Pani[✉], Ratyakshi Nain[✉], Krishna Dutt, Pradeep Kumar Muwal, Sidhharth Sirohi[✉] (2017). Facile Preparation of Biodegradable and Printable Polyester Films.

ChemistrySelect, 2(35), 11415-11421. doi:10.1002/slct.201702726 (Wiley Publication) (SCIE and Scopus Indexed Journal with an **Impact Factor of 2.307**). UGC Indexed (Sr. No. -48395). ISSN: 2365-6549 (Online).

13. Ratyakshi and R. P. Chauhan[✉] (2009). Colloidal synthesis of silver nano particles. *Asian Journal of Chemistry*, 21(10): S113-116. (Scopus and ICI Indexed journal). UGC indexed (Sr. no - 19). ISSN: 0970-7077

RESEARCH PAPERS PUBLISHED IN PROCEEDINGS (FULL PAPER)

1. Ashwini Agrawal, Ratyakshi Nain, and Manjeet Jassal .(May 17-19, 2017). ZnO nanorods-assisted carbonization of PAN nanofibers. In *Fiber Society 2017 Spring Conference: Next Generation Fibers for Smart Products*. Institute für Textiltechnik, RWTH Aachen University, Germany. Page 61.
2. Shivani Singh Surah, Siddharth Sirohi, Ratyakshi Nain, and Gulshan Kumar (2018, February). Antimicrobial activity of TiO₂ nanostructures synthesized by hydrothermal method. In *International Conference on Structural Analysis of Advanced Materials: ICSAAM 2017* (Vol. 1932, No. 1, p.1-9). AIP Publishing.030038 ; <https://doi.org/10.1063/1.5024188> Date - 19–22 September 2017, Location: Bucharest, Romania, ISBN: 978-0-7354-1624-6, Editors – Gabriel Jiga, Published: Feb 21, 2018
3. Siddharth Sirohi, Krishna Dutt, Ratyakshi Nain, Naveen Yadav, Parth Bidaliya, Vinyak, Surbhi Singh, Ashwini K. Agrawal (January 9-11, 2017). Synthesis and Characterization of Green Polyester Films. Paper published in the proceedings of *MACRO-2017: International Conference on Polymer Science and Technology*, Organized by SPSI (Society for Polymer Science), India, Thiruvanthapuram Chapter. p. 617-621.
4. Ratyakshi Nain, Manjeet Jassal, and Ashwini Agrawal (May 21-23, 2014). ZnO Rods Reinforced Polymeric Nanofibers. Paper published in the proceedings of The Fiber Society Spring 2014 Technical Conference, Fiber Research for Tomorrow's Applications, Liberec, Czech Republic.
5. Ratyakshi Nain, Manjeet Jassal, Ashwini K. Agrawal (March 09-10, 2014). ZnO nanorods/Polyacrylonitrile composite nanofibers. Paper published in the proceedings of *NCNI-2014: National conference on Nanomaterials and Instrumentation*, Organized by NIT Kurukshetra.
6. Ratyakshi and R. P. Chauhan (16 April, 2009). Synthesis and characterization of silver Nanoparticles. Paper published in the proceedings of Commune 09, A National Level Technical Paper presentation at National Institute of Technology, Kurukshetra, p. 146-149.

BOOK CHAPTERS PUBLISHED

1. Siddharth Sirohi, Ratyakshi Nain, Krishna Dutt, Balaram Pani, Nishant Jain, Ravinder Singh, Piyush Wadhwa, Gajendra Saini, and Kamlesh Panwar (2017). Synthesis of Well Dispersed ZnO Nps for Nanofinishing Textiles and Biomedical Applications. In Sabu Thomas, Yves Grohens, Nandakumar Kalarikkal, Oluwatobi Samuel Oluwafemi, K.M. Praveen (Ed.) *Nanotechnology-Driven Engineered Materials: New Insights*. CRC Press (Taylor & Francis Group). ISBN 9781771886345

PHD THESIS

Title: ZnO nanostructures reinforced composite fibers

Composite fibers reinforced with ZnO nanostructures were successfully synthesized using electrospinning as well as melt spinning techniques. The ZnO nanostructures of different aspect ratios (i.e. ZnP, ZnR and ZnW) having similar diameter (i.e. diameter of ~50 nm) were melt blended with nylon 6 chips using twin screw extruder, and subsequently, melt spun and drawn to obtain composite fibers. The incorporation of ZnO nanostructures inside nylon 6 fibers resulted in significantly better mechanical properties. The maximum strength and modulus achieved were 2.28 GPa and 10.8 GPa, respectively, with an improvement of 390 and 511%, respectively, over the control nylon 6 fibers. The combination of high strength and extension resulted in extremely high values of toughness. The energy to break was very high at 165 J/g, which is comparable to that of dragline spider silk. The presence of different ZnO nanostructures was found to change the extent of the fibrillar structure formation. The presence of anisotropic ZnO nanostructures in nylon 6, during its melt spinning and drawing, are instrumental in higher conversion of amorphous to highly oriented α crystalline regions resulting in increased α/γ ratio and increased crystallinity as well as crystalline orientation. Further, the orientation of remaining amorphous region was also increased which facilitated the formation of fibrillar structure. The use of rigid anisotropic nanostructures such as ZnR and ZnWs could yield high performance fibers using commodity grade nylon 6.

RESEARCH AREAS

High Strength & Modulus Fibres

Melt spinning of Nylon 6 composite fibers reinforced with anisotropic ZnO nanostructures was performed during PhD research work. The presence of anisotropic ZnO nanostructures in nylon 6, during its melt spinning and drawing, were found to facilitate the formation of fibrillar structure because of:

- (a) higher conversion of amorphous to highly oriented α crystalline regions
- (b) increased orientation of remaining amorphous region

The significantly higher enhancement in mechanical properties of reinforced composite nylon 6 fibers can be attributed to much better alignment of polymeric chains, formation of higher extent of α crystals with highly fibrillar morphology in the presence of anisotropic ZnO nanostructures. The anisotropic nanostructures were regulating the relaxation behavior of polymer chains during the spinning and drawing processes. Interestingly, the use of rigid anisotropic nanostructures could yield high performance fibers using commodity grade nylon 6. The work was published in *Composites Science and Technology*, (Elsevier Publication)

Carbon Fibers

Dispersion behavior of anisotropic ZnO nanorods in various polymer/solvent systems including PVA/Water, PVA/DMF-Water and PAN/DMF was investigated. Composite PAN nanofibers using specialty grade PAN with well dispersed aligned ZnO nanorods were successfully electrospun and used for the investigation of carbonization behavior. The rigid ZnO nanostructures present in the fibers played crucial role by immobilizing the polymeric chains and keeping them oriented during the initial heating process with proper distribution of heat along the fiber. With the increase in the content of these rigid nanostructures, the fraction of polymer chains experiencing the above effect increased, and hence, results in overall better graphitic structure. The incorporation of ZnO rods allowed elimination of stabilization step and significantly faster carbonization with better graphitic content. The work was published in *Nanoscale* (Royal Society of Chemistry Publication)

Reinforced composite fibers

ZnO nanowires and silica nanoparticles reinforced composite fibres of nylon 6 and polypropylene were melt spun and investigated for their mechanical and thermal properties. Melt compounding was done using twin screw extruder and the effect of wt% on dispersion and spinning behaviour was investigated.

Electrospun fibers

The nanofibers of poly (vinyl alcohol), poly(acrylonitrile), cellulose acetate, polyurethane, polylactic acid, nylon 6, poly (vinyl acetate) were successfully electrospun. The dispersion behaviour of various nanostructures including nanoparticles and nanorods was investigated for different polymer/solvent systems. The results indicate homogenous dispersion of any nanostructures and their alignment inside the fibers can be achieved when the nanostructures interact with both the polymer and the dispersing medium i.e. solvent. The work was published in *Composites Science and Technology*, (Elsevier Publication)

Bicomponent melt spinning

Pilot scale bicomponent melt spinning machine was used for the spinning of side by side and sheath-core bicomponent fibers using nylon and polyester. Hills bicomponent melt spinning was handled independently for spinning of monofilament and multifilament fibers of polypropylene, nylon 6 and polyester. Multifilament fibers were successfully spun and pilot scale trials were also performed for the industries like SRF Ltd. Spinning demonstration for M. Tech and B. Tech textile students was also organized.

Characterization and structure-property correlation of composite fibers

The instruments handled independently and used for the analysis of composite fibers spun using various techniques were Scanning Electron Microscopy and Scanning Transmission Electron Microscopy for structure. The thermal properties were analysed using TGA, DSC, DMA. The crystalline and amorphous content, crystal types and orientation analysis were performed using Wide and Small Angle X-ray Diffraction, Birefringence, Raman and FTIR. Mechanical properties like tensile strength, modulus, work of rupture, elongation at break using Instron mechanical tester. Further, the structure property correlation including the effect of morphology like polymer chain orientation, fibrillar morphology, crystallinity, crystal types, amorphous and crystalline orientation on mechanical properties was investigated.

Biodegradable polymer films

Innovation project from DU on biodegradable polymer films was successfully completed. The project involved synthesis of polyester films using polyethylene glycol, lactic acid and maleic anhydride as monomers) and their characterization of biodegradability and printability. The susceptibility of polyester films towards biodegradation was tuned by varying lactic acid concentration. The Biodegradation susceptibility of films towards fungus and bacteria i.e. *Aspergillus* sp. and *Bacillus* sp. was investigated. Films with 0.5 moles concentration of lactic acid exhibited maximum susceptibility towards degradation i. e. 39% in 60 days.

Composite Nanostructures

Synthesis and characterization of various nanostructures including non-porous and mesoporous silica, Ag, TiO₂, polystyrene nanoparticles. The adsorption behaviour dye with different functionalities was investigated on both porous and non-porous nanostructures. Hybrid nanostructures of Ag/SiO₂ for surface plasmon enhanced photocatalysis were compared for spherical and triangular morphology of silver nanoparticles. The work was published in *RSC Advances and Applied Nanoscience*. Effect of Nanoparticles Shape on Conductivity of Ag/PVA composite films was investigated (Published in *Polymer International*).

WORKSHOP ORGANIZED

	Title	Role	Duration	Organized by	In collaboration with	Organized at
1.	National Workshop on “Intellectual Property Rights”	Coordinator	5 Days (21-25 February 2022)	Bhaskaracharya College of Applied Sciences, University of Delhi, Delhi, India	School of Management, NIT Rourkela, India	Bhaskaracharya College of Applied Sciences, University of Delhi, Delhi, India
2.	'Basic Techniques involved in Industrial Microbiology for Product Development	Coordinator	6 Days (December 16-21, 2021)	Bhaskaracharya College of Applied Sciences, University of Delhi, Delhi, India	IIIM-Technology Business Incubator, CSIR-IIIM, Jammu	Bhaskaracharya College of Applied Sciences, University of Delhi, Delhi, India
3	PFMS-EAT (Public Financial Management System - Expenditure Advance and Transfer	Coordinator	1 day (January 03, 2018)	Bhaskaracharya College of Applied Sciences, University of Delhi, Delhi, India	DBT, Government of India	Bhaskaracharya College of Applied Sciences, University of Delhi, Delhi, India

SHORT TERM COURSES ORGANIZED

	Title	Role	Duration	Organized by	Organized at
1	Environmental Friendly Teaching Learning Practices	Coordinator & Resource Person	1 Month & 6 days (5 June-11 July 2021)	Bhaskaracharya College of Applied Sciences, University of Delhi, Delhi, India	Bhaskaracharya College of Applied Sciences, University of Delhi, Delhi, India
	30 hours short term certificate course on sustainable development goals and making sustainable environmental	Coordinator	May 22-26, 2023	Department of Microbiology, Bhaskaracharya College of Applied Sciences, University of Delhi, Delhi, India	Bhaskaracharya College of Applied Sciences, University of Delhi, Delhi, India

ACADEMIC ACHIEVEMENTS

- 1st prize in Paper presentation, Tekstyle 2015, April 1-3, IIT Delhi.
- Distinction in PhD
- Gold Medalist in M.Tech (Nanotechnology), National Institute of Technology, Kurukshetra.
- Gold Medalist in M.Sc, Kurukshetra University, Kurukshetra.
- Qualified **CSIR-UGC NET**, Dec-2008
- Qualified **GATE-2007**
- 1st prize in Intercollege Quiz Competition, Directorate Of Wheat Research, Karnal
- 1st prize in Intercollege Quiz Competition, D.A.V college, Karnal
- 3rd prize in Inter Deptt Quiz Competition Zoology Deptt Kurukshetra University
- 3rd prize in poster competition D.A.V college Karnal

PERSONAL PROFILE

Date of Birth	:	December 05, 1985
Gender	:	Female
Marital Status	:	Married
Nationality	:	Indian
Languages Known	:	English, Hindi, Sanskrit
Hobbies & Interests	:	Research, facilitating teaching learning process, helping the needy, listening to music & writing poems.