


## Brief Biodata

**Name: Dr. Shankar Gopal Aggarwal**

<b>Designation:</b>	Senior Principal Scientist	
<b>DP No. and Name:</b>	Gas Metrology, 3.02	
<b>DU No. and Name:</b>	Environmental Sciences & Biomedical Metrology Division	
<b>Email:</b>	aggarwalsg@nplindia.org	
<b>Date of Joining CSIR-NPL:</b>	15.04.2009	
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### Research Area/ Interest

Particle and gas metrology, aerosol chemistry and physics, air quality measurement and instrumentation, control technology development and measurement

### Educational Qualifications

*(Please write latest qualification first)*

Degree	Subject	University/ Institute	Year
Ph.D.	Chemistry	Pt. Ravishankar University, Raipur	1999
PGDCA	C, FORTRAN, COBOL, UNIX	Pt. Ravishankar University, Raipur	1994
M.Sc.	Chemistry	Pt. Ravishankar University, Raipur	1992
B.Sc.	Physics, Chemistry, Physics	Pt. Ravishankar University, Raipur	1990

### Academic / Research Experience

Grade / Post	Institute	Duration		Research Field
		From	To	
Principal Scientist	CSIR-National Physical Laboratory	April 2017	Till date	Particle and gas metrology, aerosol chemistry and physics, air quality measurement and instrumentation, control technology development and measurement
Principal Scientist	CSIR-National Physical Laboratory	April 2013	April 2017	Particle and gas metrology, aerosol chemistry and physics, air quality measurement and

				instrumentation, control technology development and measurement
Senior Scientist	CSIR-National Physical Laboratory	April 2009	April 2013	Particle and gas metrology, aerosol chemistry and physics, air quality measurement, metrology in chemistry
University post doctoral fellow	Hokkaido University, Japan	May 2007	March 2009	Aerosol Micro-Physical and Molecular Chemical, Isotope Characterization
JSPS fellow	Hokkaido University, Japan	May 2005	April 2007	Aerosol Micro-Physical and Molecular Chemical, Isotope Characterization
Researcher	Industrial Technology Research Institute (DI), Taiwan	December 2002	April 2005	Stake emission measurement, control technology
CSIR-RA	Pt Ravishankar Shukla University, Raipur, India	April 2000	September 2001	Atmospheric chemistry
NSC post doctoral fellow	National ChiaoTung Univeristy, Hsinchu, Taiwan	October 2001	September 2002	Aerosol physics, control technology
CSIR-RA	Pt Ravishankar Shukla University, Raipur, India	April 2000	September 2001	Atmospheric chemistry

## No. of Publications

No. of Publications in SCI Journals	No. of Publications in non-SCI Journals	No. of Publications in Conference Proceedings	Books	Total
>80	>10	>150	5	>245

## Selected Publications

- **Emission monitoring and control technology**

Chuen-Jinn Tsai, Shankar G. Aggarwal, Chung-Tso Chang, I-Fu Hung, Concentration Profiles of Acidic and Basic Air Pollutants Around an Industrial Park of Taiwan, Water, Air, & Soil Pollution, 151, 287-304, 2004.

HungMin Chein, Tzu Ming Chen, Shankar G. Aggarwal, Chuen-Jinn Tsai, Chun-Chao Huang, Inorganic Acids Emission Factors of Semiconductor Manufacturing Processes, Journal of Air & Waste Management Association, 54, 218-228, 2004.

Hungmin Chein, Shankar G. Aggarwal, Hsin-Hsien Wu, Efficient Control System for Low-Concentration Inorganic Gases from Process Vent Stream: Application of Surfactants in Spray and Packed Column, Environmental Science & Technology, 38, 5766-5772, 2004.

Hung Min Chein, Shankar Gopala Aggarwal, Hsin Hsien Wu, Tzu Ming Chen, Chun-Chao Huang, Field Enhancements of Packed Bed Performance for Low-Concentration Acidic and Basic Waste-Gases from Semiconductor Manufacturing Process, Journal of Air & Waste Management Association, 55, 647-657, 2005.

HungMin Chein, Yu-Du Hsu, Shankar G. Aggarwal, Tzu-Ming Chen, Chun-Chao Huang, Evaluation of arsenical emission from semiconductor and opto-electronics facilities in Hsinchu, Taiwan, Atmospheric Environment, 40(10), 1901-1907, 2006.

- **Scientific interpretation based on aerosol physical/optical characterization**

Chuen-Jinn Tsai, Jyh-Shyan Lin, Shankar G. Aggarwal, Da-Ren Chen, Thermophoretic Deposition of Particles in Laminar and Turbulent Tube Flows, Aerosol Science and Technology, 38, 131-139, 2004.

Shankar Gopala Aggarwal, Michihiro Mochida, Yasuyuki Kitamori, Kimitaka Kawamura, Chemical Closure Study on Hygroscopic Properties of Urban Aerosol Particles in Sapporo, Japan, Environmental Science & Technology, 41, 6920-6925, 2007.

Mochida, M., C. Nishita-Hara, Y. Kitamori, S. G. Aggarwal, K. Kawamura, K. Miura, A. Takami, Size-segregated measurements of cloud condensation nucleus activity and hygroscopic growth for aerosols at Cape Hedo, Japan in spring 2008, Journal of Geophysical Research, 115, D21207, 2010.

Jinsang Jung, Young J. Kim, Shankar Gopala Aggarwal, Kimitaka Kawamura, Hygroscopic property of water-soluble organic-enriched aerosols in Ulaanbaatar, Mongolia during the cold

winter of 2007, *Atmospheric Environment*, 45, 2722 – 2729, 2011.

Comparison of Experimental and Modeled Absorption Enhancement by Black Carbon (BC) Cored Polydisperse Aerosols under Hygroscopic Conditions, *Environ. Sci. Technol.*, 46 (15), 8082–8089, 2012.

Bighnaraj Sarangi, Shankar G. Aggarwal, Deepak Sinha, and Prabhat K. Gupta, Aerosol effective density measurement using scanning mobility particle sizer and quartz crystal microbalance with the estimation of involved uncertainty, *Atmos. Measurement Techniques*, 9, 859–875, 2016.

B. Sarangi, S.G. Aggarwal, B. Kunwar, S. Kumar, R. Kaur, D. Sinha, S. Tiwari, K. Kawamura, Nighttime particle growth observed during spring in New Delhi: Evidences for the aqueous phase oxidation of SO<sub>2</sub>, *Atmos. Environ.*, 188, 82–96, 2018.

- **Scientific implementation based on aerosol chemical and isotope analysis**

Shankar G. Aggarwal, Kimitaka Kawamura, Molecular distributions and stable carbon isotopic compositions of dicarboxylic acids and related compounds in aerosols from Sapporo, Japan: Implications for photochemical aging during long-range atmospheric transport, *Journal of Geophysical Research*, 113, D14301, 2008.

Shankar G. Aggarwal, Kimitaka Kawamura, Carbonaceous and inorganic composition in long-range transported aerosols over northern Japan: Implication for aging of water-soluble organic fraction, *Atmospheric Environment*, 43, 2532-2540, 2009.

Yuzo Miyazaki, Shankar G. Aggarwal, Khem Singh, Prabhat K. Gupta, Kimitaka Kawamura, Dicarboxylic acids and water-soluble organic carbon in aerosols in New Delhi, India in winter: Characteristics and formation processes, *Journal of Geophysical Research*, 114 (D19), 1984–2012, 2009.

S. Agarwal, S. G. Aggarwal, K. Okuzawa, K. Kawamura, Size distributions of dicarboxylic acids, ketoacids,  $\alpha$ -dicarbonyls, sugars, WSOC, OC, EC and inorganic ions in atmospheric particles over Northern Japan: Implication for long-range transport of Siberian biomass burning and Asian polluted aerosols, *Atmospheric Chemistry and Physics*, 10, 5839-5858, 2010.

Sudhanshu Kumar, Shankar G. Aggarwal, Prabhat K. Gupta, Kimitaka Kawamura, Investigation of the tracers for plastic-enriched waste burning aerosols, *Atmospheric Environment* 108,49-58, 2015.

S. Kumar, S.G. Aggarwal, J. Malherbe, J.P.G. Barre, S. Berail, P.K. Gupta, O.F.X. Donard, Tracing dust transport from Middle-East over Delhi in March 2012 using metal and lead isotope composition, *Atmospheric Environment* 132, 179-187, 2016.

Pingqing Fu, Shankar G. Aggarwal, Jing Chen, Jie Li, Yele Sun, Zifa Wang, Huansheng Chen, Hong Liao, Aijun Ding, G. S. Umarji, R. S. Patil, Qi Chen, and Kimitaka Kawamura, Molecular Markers of Secondary Organic Aerosol in Mumbai, India, *Environmental Science and Technology*, 50, 9, 4659–4667, 2016.

- **Studies on bioaerosol and related compounds**

Agarwal S., Mandal P., Majumdar D., Aggarwal S.G., Srivastava A., Characterization of Bioaerosols and their Relation with OC, EC and Carbonyl VOCs at a Busy Roadside Restaurants-Cluster in New Delhi, *Aerosol and Air Quality Research*, 16, 3198–3211, 2016.

Kumar S., Aggarwal S.G., Fu P.Q. Kang M., Sarangi B., Sinha D., Kotnala R.K. Size-segregated sugar composition of transported dust aerosols from Middle-East over Delhi during March 2012, *Atmos. Research*, 189, 24–32, 2017.

- **Air monitoring technology development**

Chuen-Jinn Tsai, Kai-Chung Cheng, Shankar G. Aggarwal, Tung-Sheng Shih, I.-Fu Hung, Simultaneous Sampling of Gaseous- and Aerosol-Phase TDI with a Triple Filter System, *Journal of Air & Waste Management Association*, 53, 1265-1272, 2003.

Prashant Patel, Shankar G. Aggarwal, Chuen-Jinn Tsai, Tomoaki Okuda, Theoretical and field evaluation of a PM<sub>2.5</sub> high-volume impactor inlet design, *Atmospheric Environment*, 244, 117811, 2021.

Prashant Patel, Shankar G. Aggarwal, Theoretical and Experimental Evaluation of a Compact Aerosol Wind Tunnel and its Application for Performance Investigation of Particulate Matter Instruments, *Aerosol and Air Quality Research*, 21(7), 1-20, 2021.

- **Air quality metrology (standards and calibration)**

Shankar G. Aggarwal, Recent Developments in Aerosol Measurement Techniques and the Metrological Issues, *MAPAN Journal of Metrology Society of India*, 25 (3), 165-189, 2010.

Shankar G. Aggarwal, Sudhanshu Kumar, Papiya Mandal, Bighnaraj Sarangi, et al., Traceability issue in PM<sub>2.5</sub> and PM<sub>10</sub> measurements, *MAPAN- Journal of Metrology Society of India*, 28(3), 153-166, 2013.

Bighnaraj Sarangi, Shankar G. Aggarwal, Prabhat K. Gupta, Performance Check of Particle Size Standards within and after Shelf-life using Differential Mobility Analyzer, *Journal of Aerosol Science*, 103, 24–37, 2017.

Rishu Agarwal, Shankar G. Aggarwal, Absorption Efficiency Assessment and Uncertainty Measurement of the Sodium Arsenite Method for Ambient NO<sub>2</sub> Determination, *Aerosol and Air Quality Research*, 21(3), 1–12, 2020.

Gung-Hwa Hong, Thi-Cuc Le, -- , Shankar G. Aggarwal, Chuen-Jinn Tsai, Long-term evaluation and calibration of three types of low-cost PM<sub>2.5</sub> sensors at different air quality monitoring stations, *Journal of Aerosol Science*, 157, 2021, 105829

Kritika Shukla, Shankar G. Aggarwal, Performance check of beta gauge method under high PM<sub>2.5</sub> mass loading and varying meteorological conditions in an urban atmosphere, *Atmospheric Pollution Research*, 12, 2021, 101215.

## **Patents**

Method and apparatus for analysing multiple species, Taiwan Patent, No. 093141381, Date: 30.12.2004

Method and apparatus for treating waste gas containing acid and/or base, US Patent, No. US

2005/0053536 A1, Date 10.03.2005

A method for number count efficiency checks of particular counter based on corresponding particle mass collected in parallel, Indian Patent, No. 2336DEL2015, Date: 03.02.2017

Particulate matter sampler, US Patent, No. US 10782212 B2, Date: 22.09.2020

Tangential six-inlet co-cylindrical cyclone for PM10 sampling, Indian Patent, No. 202111014940, Date: 31.03.2021

A mask testing setup, Indian Patent, No. 202111045226, Date: 05.10.2021

### **Current Activities**

*(Not more than 100 words)*

Dr. Shankar's current research focus is "metrology for national ambient air quality standards (NAAQS)" in which he involves in preparation of gas standards, PM<sub>2.5</sub> sampler development and its calibration work, performance evaluation of air monitoring instruments, sensors, etc. Also, they have designed and developed an aerosol wind tunnel facility at CSIR-NPL for cutoff size calibration of aerosol samplers, first in India. So far, 4 students have been awarded Ph.D. degree under his supervision. At present 6 students are registered with him for Ph.D. degree.

### **Honour(s)/Award(s)/ Fellowship(s)**

<b>S. No.</b>	<b>Name of the award/recognition</b>	<b>Year</b>	<b>Awarding Org./ Inst. CSIR, India</b>	<b>Brief citation of the award work/remarks</b>
1	PDF award	2001	NSC, Taiwan	Studied thermophoretic deposition technique for particle deposition from industrial waste gas
2	Best research team member award, ITRI, Taiwan	2004	ITRI, Taiwan	Developed waste gas treatment technology for TSMC, Taiwan
3	JSPS award	2005	JSPS, Japan	Studied/development of HTDMA for hygroscopicity measurement of aerosol particles, studied CCN activity of particles
4	Best paper award in AAC2011, Xi'an, China	2011	Asian Aerosol Research Assembly	Isotopic changes in aged atmospheric aerosols as indicator for their photochemical aging
5	Associate Editor of MAPAN	2014	Publisher: Springer	Journal theme is "Metrology"
6	CITAC award-2013, France	2015	Cooperation on International Traceability in Analytical Chemistry (CITAC)	Traceability Issue in PM <sub>2.5</sub> and PM <sub>10</sub> Measurements
7	Technology Licensed Award	2017	CSIR-National Physical Laboratory	High-Volume PM <sub>2.5</sub> Impactor Sampler

8	Associate Editor of Asian Journal of Atmospheric Environment	2018	Publisher: Asian Association for Atmospheric Environment	
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### **Contributions to AcSIR**

He is the course coordinator of Ph.D. credit course “Air Quality Measurement Science and Technology” for AcSIR. Also he is the faculty member of other 3 courses of AcSIR. He is one of the coordinators of CSIR 800 project course at CSIR-NPL.

### **Membership of Professional Societies/ Institutions**

He is also the member of gas and air pollution related committees of Bureau of Indian Standards (BIS). He is the Associate Editor of 2 international journals. He is a life member of several scientific societies including: MSI, IASTA, ISAS, IAAPC, etc.

### **Any other Information**

*(Not more than 100 words)*

He is the PI /Co-PI of several national and international scientific projects. He also serves his duties as assessor (ISO 17034: 2016 and ISO/IEC 17025:2017) for National Accreditation Board for Testing and Calibration Laboratories (NABL).