SUJAY D. BAGI

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PROFESSIONAL SYNOPSIS

Materials Scientist and Research Assistant in Mechanical Engineering at MIT with focus on developing high-throughput synthesis pathways for accelerated crystallization of Metal–Organic Frameworks (MOFs) and Zeolites. Previous experience of 5+ years in Diesel Aftertreatment System, Lubricants, and Tribology. Effective communicator with expertise in project management, product design & dev.

PROFESSIONAL CONTOUR

Jul'16 – Present | **Massachusetts Institute of Technology (MIT)** | **Research Assistant**

- Research thesis focused on developing flow chemistry platform for energy- & cost-efficient synthesis of *MOFs & Zeolites*, used in atmospheric water harvesting, heat pumps, gas storage, drug delivery, and catalysis.
- Developed *techno-economic framework* and *CFD* models to evaluate potential scalability & trade-off scenarios for manufacturing industrially relevant MOFs at *kg scale*, with an overall goal to reduce synthesis costs for widespread deployment.
- Computed activation energies and rate constants for nucleation & growth of MOF-808 (Zr) via SAXS & reaction quenching in flow.
- Evaluated sinter-resistant core-shell (Pt/Pd-TiWC) catalysts for gasoline engine using packed-bed down-flow reactor.
- Performed engine bench-tests to simulate accelerated DPF aging to elucidate ash sintering, transport and effects on filter ΔP.

Feb'13 – Jun'16 | **Paccar Inc** | **Sr. R&D Engineer - Powertrain Systems**

- Developed strategies for Diesel Engine Aftertreatment System: Understanding physical/chemical interactions of soot & ash that affect DPF filtration (ΔP) & catalyst performance, DPF maintenance intervals, and approach for NOx control.
- Evaluated *failure modes and wear mechanisms* for MX powertrain components related to Engine oils, Fuels, Coolants, Greases & Driveline fluids using materials characterization techniques during vehicle design and production stages.
- Served as a technical resource to monitor automotive industry trends, legislation, and participate in development of industry standards (PC-11 / NCDT / ASTM) related to Fluid systems & Emissions, of practical significance to Paccar products.

Jan'11 – Dec'12 | **University of Texas at Arlington** | **Research Assistant**

- Research thesis focused on developing high performance EP grease additives & surface analysis to elucidate wear mechanisms.
- Performed comprehensive studies on investigation of structural, oxidative and morphological aspects of diesel engine soot extracted from crankcase and exhaust stream.

May'12 – Aug'12 | **Albemarle Corporation** | **Intern - Polymer Solutions R&D**

- Formulated aminic and phenolic antioxidant chemistries used in power-plant turbine oils for long-term durability. Investigation of oil degradation behaviour and varnish deposits using oxidation bench tests, analytical & statistical tools, and condition monitoring.

Jul'09 – Jun'10 | **John Deere India Pvt Ltd** | **Engineer - Product Design and Analysis**

- Involved in the product development of hydraulic system control-valve for small tractors, including conceptualization, market segmentation, detailed design, prototype development, and reliability testing in adherence with the quality & cost standards.

ACADEMIC CREDENTIALS

2021	Ph.D. Candidate in Mechanical Engineering	Massachusetts Institute of Technology (GPA 4.7/5.0)
2012	M.S. in Materials Science and Engineering	University of Texas at Arlington (GPA 3.6/4.0)
2009	B.E. in Mechanical Engineering	BMS College of Engineering, Bangalore, India (72.91%)

SCHOLARSHIPS & PROFESSIONAL MEMBERSHIP

- Awarded *Tata Trusts fellowship* (2017-19, MIT) for developing sorbents used in heavy-metal sequestration from industrial wastewater and hydrogen/methane storage for automotive applications.
- Materials Science Dept. scholarship (2011-12, UTA) & STLE North Texas Scholarship for Tribological Research (2012).
- *Memberships* in: STLE (Engine & Drivetrain Technical Committee: PS Chair), EMA (Truck & Engine Manuf. Association), LC (Lubricants Committee), DFC (Diesel Fuel Committee), & *PC-11 taskforce* (Volvo T-13, Daimler Scuffing, CAT Aeration Test). Contributed toward the development of next generation fuel-efficient diesel engine oil standard (*API CK-4* & *FA-4*, 2014-16).

INDUSTRIAL & ACADEMIC WORKSHOPS

- *Fuels, Biofuels, Engine Oils and Drivetrain Fluids* Workshop - Afton Chemicals R&D Centre (Richmond, VA - 06/2015)
- Engine and Drivetrain Components for *Trucks & Heavy Equipment* - Paccar Technical Centre (Mt Vernon, WA - 04/2014)
- *Lubrication and Fuels Conference* **-** Lubrizol R&D Centre (Wickliffe, OH - 09/2014)
- *GD&T* (Geometric Dimensioning & Tolerancing) Workshop & Manufacturing *Aluminium Hybrid Composites* (04/2010)

TECHNIQUES – Materials Characterization & Mechanical Modelling/Simulation

- **Electron Microscopy & Spectroscopy**: SEM, TEM, XPS, AES. **X-ray Analysis**: XRD, SAXS, XRF, EDS. **Molecular Vibrational Spectroscopy**: Raman, FTIR. **Surface Analysis**: WLI, GDS, AFM. **Thermal Analysis**: TGA, DSC.

- **Chemical Analysis**: ICP-OES, GC-MS, BET, DLS, TAN, TBN, Calorimetry, Flash/Pour/Cloud Point Tests.
- **Tribology & Lubricant Analysis**: 4-Ball, HFRR, SRV, BOCLE, Pin-On-Disk, HTHS, KV, RPVOT, TEOST, TFOUT.
- **Modelling & Analysis**: COMSOL, OriginLab, SolidWorks, ANSYS, Minitab, Design Expert (DOE), 3D Printing (SLA/FDM).

PUBLICATIONS (*Updated* ***July 2020***)

- Bagi, S., Bowker, R., and Andrew, R., "Understanding Chemical Composition & Phase Transitions of Ash from Field Returned DPF Units and their Correlation with Filter Operating Conditions", SAE Int. J. Fuels Lubr. 9(1):2016, *DOI: 10.4271/2016-01-0898*
- Bagi S., Sharma V., Patel M., and Aswath P., "Effects of Diesel Soot Composition and Accumulated Vehicle Mileage on Soot Oxidation Characteristics", Energy and Fuels, 2016, 30(10), 8479-8490. *DOI: 10.1021/acs.energyfuels.6b01304*
- Bagi S., Sharma V., and Aswath P., "Role of Dispersant on Soot-Induced Wear in Cummins ISB Engine", Carbon, 2018, 136, 395-408. *DOI: 10.1016/j.carbon.2018.04.066*
- Bagi, S., Singh, N., and Andrew, R., "Investigation into Ash from Field Returned DPF Units: Composition, Distribution, Cleaning Ability and DPF Performance Recovery", SAE Technical Paper 2016-01-0928, 2016. *DOI: 10.4271/2016-01-0928*
- Kamp, C., Zhang, S., Bagi, S. et al., "Ash Permeability Determination in the Diesel Particulate Filter from Ultra-High Resolution 3D X-Ray Imaging and Image-Based Direct Numerical Simulations," SAE Int. J. Fuels Lubr. 10(2):2017. *DOI: 10.4271/2017-01-0927*
- Sharma V., Bagi S., Patel M., and Aswath P., "Influence of engine age on morphology and chemistry of diesel soot extracted from crankcase oil", Energy and Fuels, 2016, 30(3), 2276-2284. *DOI: 10.1021/acs.energyfuels.5b02512*
- Bagi S.D., Aswath, P.B. Mechanism of Friction and Wear in MoS_2 and ZDDP/F-PTFE Greases under Spectrum Loading Conditions. Lubricants 2015, 3(4), 687-711. *DOI: 10.3390/lubricants3040687*
- Kamp, C. J., Bagi, S., & Wang, Y. (2019). Phenomenological Investigations of Mid-Channel Ash Deposit Formation and Characteristics in Diesel Particulate Filters. SAE Technical Paper 2019-01-0973. *DOI: 10.4271/2019-01-0973*
- Kamp, C. J., & Bagi, S., (2019). Advanced analytical methods for the study of lubricant-derived ash and associated impacts on engine aftertreatment components. SAE Technical Paper *2019-01-2293. DOI: 10.4271/2019-01-2293*
- S. D. Bagi and P. B. Aswath "Role of MoS_2 Morphology on Wear & Friction Coefficient under Spectrum Loading Conditions", Lubr. Sci., 27: 429-449. *DOI: 10.1002/ls.1296*
- Sharma V., Bagi S., Patel M., Aderniran S., and Aswath P., "Structure and Chemistry of Soot and its Role in Wear of Diesel Engines", Tribology Online, 11, 5 (2016) 551-555. *DOI: 10.2474/trol.11.551*
- Shah, A., Bagi, S. and Aswath, P., 2017. Wear and Friction of Greases Containing Organic and Inorganic Sulfur Carriers. Tribology Online, 12(4), pp.162-170. *DOI: 10.2474/trol.12.162*
- Bagi, S., Vyavhare, K., and Aswath, P., "Tribological characteristics of greases with and without metallo-organic friction-modifiers". Tribology - Materials, Surfaces & Interfaces, 12:4, 223-236, 2018. ISSN: 1751-5831. *DOI: 10.1080/17515831.2018.1542790*
- Vyavhare, K., Bagi, S., Patel, M., and Aswath, P., "Impact of diesel engine oil additives-soot interactions on physiochemical, oxidation and wear characteristics of soot". Energy and Fuels, 2019, 33(5), 4515-4530, *DOI: 10.1021/acs.energyfuels.8b03841*
- S. D. Bagi., Effect of Additive Morphology & Chemistry on Wear & Friction of Greases under Spectrum Loading, *M.S. Thesis*, 2012. DOI: *https://uta-ir.tdl.org/uta-ir/handle/10106/25525*
- Bagi, S. et al., High Throughput Synthesis of Metal–Organic Frameworks for Atmospheric Fresh Water Capture, 2020, *Manuscript in preparation*.
- Bagi, S. et al., Continuous Flow Chemistry Approach for Ultrafast and Low-Cost Synthesis of MOF-808 and Techno-Economic Analysis, 2020, *Manuscript in preparation*.
- Bagi S., Kamp C. J., Sharma V., and Aswath P., Multiscale Characterization of Exhaust and Crankcase Soot Extracted from Heavy-Duty Diesel Engine and Implications for DPF Ash, 2020, Fuel, *JFUE-D-20-03448*.
- Vyavhare, K., Bagi, S., Pichumani, P., and Aswath, P., Chemical and Physical Properties of Tribofilms formed by the Interaction of Ashless Dithiophosphate Anti-wear Additives, 2020, *Manuscript in preparation*.
- Yuan, S. … Bagi, S. et al., Conversion of Methane into Liquid Fuels – Bridging Thermal Catalysis with Electrocatalysis, 2020, Advanced Energy Materials, *AENM 202000268*.

PATENTS

- Aswath, P. B., Bagi, S., Shah, A., Shah, K., and Mordaunt, K. "Lubricant Compositions." U.S. Patent 20,170,066,990, *Issued March 9, 2017*. (Application Number - 15/259,608)
- Bagi, S. and Román-Leshkov, Y., High-throughput Flow Synthesis of Crystalline Microporous Materials On-demand. *US Provisional Patent Application, 2019*.

POSTER PRESENTATIONS

- Bagi, S. and Román-Leshkov, Y., On-demand Synthesis of Zeolites In-Flow for Water Purification, Tata Center for Technology & Design, *MIT*, 2018.
- Bagi, S. and Román-Leshkov, Y., High-throughput Synthesis of Metal–Organic Frameworks (MOFs) for Catalysis and Water Uptake, Tata Center for Technology & Design, *MIT*, 2019.
- P. Pitchumani, S. Bagi, V. Sharma, and P Aswath**, "**Wear and Tribofilm Formation with Zinc-Free Antiwear Additives "Fundamentals II, STLE 67th Annual Meeting, St. Louis. MO, May 6th -10th, 2012. p. 28. (Tribology & Lubrication Technology 2 (2013): 1.)
- Kamp, C. J., … Bagi, S., et al., High-Resolution X-Ray Computed Tomography and Direct Numerical Simulation for the Measurement and Calculation of Decreased Permeability in the Wall-Flow Diesel Particulate Filter due to the Accumulation of Lubricant-Derived Ash, *Materials Research Society*, TC02.03.09, 2017.

PEER-REVIEWER FOR SCHOLARLY JOURNALS

- SAE International Journal of Fuels and Lubricants (*ISSN: 1946-3952*): 30+ papers reviewed
- Emission Control Science and Technology (*ISSN: 2199-3637*): 2+ papers reviewed

MAJOR PROJECTS EXECUTED

Description	Project Synopsis
Development of High-Throughput Flow Chemistry Platform for Material Synthesis On-demand (06'2017 - present)	• Designed & built a modular and scalable materials discovery platform, for ultrafast synthesis of porous materials (Zeolites & MOFs) on a *gram to kg scale*. • Employed microfluidic reactions using biphasic liquid-liquid slug flow to perform continuous crystallization; miniaturized reactions (µL to mL) enable fast heat/mass transport accelerating synthesis • Supervised machine learning modules coupled with rapid synthesis helps minimize time-consuming steps in screening large number of reaction space parameters and aids pilot-scale production. • Employed a robust *techno-economic model* coupled with *CFD* simulations to analyse cost and energy savings achieved in flow compared to batch, and scalable configurations to synthesize at *kg* scale.
Harvesting Fresh Water from Air (07'2019 - 05'2020)	• Employed flow chemistry for accelerated crystallization of *Ni_2Cl_2BTDD* MOF–adsorbs nearly its own weight of water from air, delivering unprecedented performance in water harvesters & heat pumps. • Explored chemical synthesis space of solvents, residence time and temperature, using DoE to minimize synthesis costs enabling widespread deployment of sorbent-based devices. • Atmosphere holds ~10% of global fresh water. Energy- & cost-efficient capture along with decentralized distribution in remote arid areas would be a major breakthrough to address water scarcity.
Evaluate Crystallization Kinetics for industrially attractive MOFs (07'2020 - present)	• Employed rapid sampling module developed in-house to quench crystallization reactions for *MOF-808* (*Zr*), an industrially attractive MOF with open metal sites, used in catalysis, heat pumps, separation etc. • Determined activation energies and rate constants for nucleation and crystal growth using Gualtieri model for solution-mediated transformation. • Explored the effects of coordination modulation, temperature, & linker concentration on particle sizes.
MIT Consortium on Diesel Engine Lubricants & Emission Control System (06'2016 - 05'2017)	• Developed bench-tests to simulate accelerated lubricant ash loading in DPF and monitor ash transport, HC light-off performance, mid-channel ash deposits and filter backpressure (ΔP). • Computed permeability of aged filters taking into account resistances of filter wall and ash morphology, using X-ray CT (Computed Tomography) and CFD models. • Evaluation of hydrated ash species on filter durability & correlations with vehicle operating environment.
Tailoring Hardware Specific Engine Oils (CK-4) for Improved Vehicle Fuel Economy (10'2014 - 04'2016)	• Executed the collaborative project from conception to engine testing with a goal of establishing engine-oil performance standard for MX13/MX11 engines. • Additive chemistry formulations with low-ash & low-P content were developed for enhanced MX engine durability and improved service life of DPF catalyst. • Developed and evaluated low HTHS engine oils to understand effects on engine durability and achieved ~0.5% fuel-economy improvement on MX platform.
After-treatment Performance & Extension of DPF Service Intervals (06'2013 - 02'2015)	• Collaborated with Cummins for evaluation of efficient DPF ash cleaning protocols. Dry or wet methods that recovered catalyst performance while removing most of the ash (lose & sintered) were selected. • Investigated the relationship between accumulated vehicle mileage, duty-cycles, ash morphology (chemical makeup & distribution) and DOC/DPF catalyst performance for extension of DPF cleaning intervals of on-highway vehicles.
Projects at University of Texas at Arlington (04'2011 - 02'2013)	• Research collaboration with Boeing for development of Low Friction Aerospace Greases under spectrum loading conditions for landing gear application. • Studied chemical & structural characteristics of tribofilms from Ashless Anti-Wear additives.

Areas of Interest: Materials Development, Renewable Energy Technologies, Crystallization Science, MOFs, Automotive Emissions.
References provided on request.