Pujan Biswas

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pujanbiswas Pujan Biswas

Stanford | ENGINEERING
Mechanical Engineering

EDUCATION

Stanford University, Stanford, USA *(Jan '21 - Present)*

PhD Candidate, Mechanical Engineering | Advisor: Prof. Ronald K. Hanson | GPA: 4.034/4

- Research focus: Devise advanced optical diagnostics to test extreme environments and model using ML

Indian Institute of Technology Bombay, Mumbai, India *(Jul '16 - Aug '20)*

Bachelor of Technology (Honors), Aerospace Engineering | Minor in Electrical Engineering | GPA: 9.43/10

- Research focus: Deploy CFD solvers to simulate novel energy systems and conduct experimental testing

TECHNICAL SKILLS

Softwares	ZeMax, Lumerical, CHEMKIN, Origin, LabVIEW, Solidworks, KLayout, Sentaurus
Programming	Python, MATLAB, scikit-learn, Cantera, OpenFOAM, OpenMP, OpenMPI
Applied optics	CO_2 gas lasers, DFB lasers, UV lasers, pulsed lasers, fiber-coupled sensors, reflective & refractive optics, HgCdTe, InGaAs detectors, scanned & direct absorption spectroscopy
Lab experience	Ultra-high vacuum systems, laser alignment, opto-mechanical mounting, lithography, IC design and CMOS fabrication in cleanroom, electrical testing, imaging & photodetection

INDUSTRY EXPERIENCE

Advanced metasurfaces as infrared waveguides | *Optical Sensing, Apple* *(Jun '25 - Sep '25)*

- Engineered a novel and compact **plasmonics-based optical filter** offering customizable tunability across broad wavelength bands (in the IR) with a significantly smaller footprint and improved performance
- Spearheaded multi-parameter optimization of filter geometries by integrating a genetic-algorithm search framework with **GPU-accelerated FDTD simulations** to meet stringent design specifications
- Designed a new, easy-to-use FTIR plus integrating-sphere platform for IR filter characterization, delivering rapid and **high-fidelity mid- and long-wave IR scattering, reflection, and transmission** datasets
- Advanced real-world device modeling via a Python-based pipeline that seamlessly integrates high-resolution spectroscopic data into legacy workflow, boosting prediction accuracy under atmospheric conditions

RESEARCH EXPERIENCE

Rapid fuel prescreening using FTIR spectroscopy and machine-learning *(Apr '22 - Present)*

- Conducted **laser absorption spectroscopy-based, time-resolved measurements** of $C_1 - C_4$ hydrocarbons in a shock tube between $1000 - 1600$K during the pyrolysis of transportation-relevant fuels
- Characterized the effects of molecular structure on the thermal decomposition and combustion behavior of $C_5 - C_{12}$ hydrocarbons by investigating salient differences in the distribution of measured products
- Leveraging observed characteristics to develop **a compact and machine learning-based framework** for predicting engine suitability of novel fuels using their molecular fingerprint in the infrared spectra

Full-stack implementation and characterization of integrated circuits *(Jan '25 - Apr '25)*

- Designed MOSFETs, inverters and associated devices in KLayout and fabricated these using a **full CMOS-compatible process flow**, including ion implantation, lithography, metallization, and etching steps
- Simulated the complete device process in Synopsys Sentaurus and measured key electrical characteristics (e.g., I-V, C-V curves) of the devices for comparison against analytical models and process simulations

- Extracted and analyzed crucial device parameters (e.g., leakage current, subthreshold slope) to explain non-ideal behavior, linking deviations to specific process steps, layout choices, and parasitic effects

Multiplexed laser diagnostic array for probing sub-μs fuel chemistry *(Oct '21 - Jul '24)*

- Led the development of a **mid-IR diagnostic system** using an **external-cavity quantum cascade laser (ECqcl)** for sensing CH_2O, a key combustion intermediate, between $700-1500$K and $10-60$atm
- Performed combustion characterization of gasoline-surrogates, real gasolines (with renewables), traditional and alternative jet fuels using multi-wavelength speciation of CH_2O and CO in a high-pressure shock tube
- Devised **a physics-informed, compact and accurate chemical kinetic model** to aid in the design of advanced engine concepts (e.g., low-temperature combustion, HCCI) operating on real fuels

Advanced optical design strategies for high-energy sources *(Jan '24 - Apr '24)*

- Leveraged the **mixed mode ray tracing utility in Zemax** to design and optimize a stacked paraboloid-hyperboloid shell architecture (Wolter-I telescope) for successfully sensing soft X-rays within a 40' FOV

Optical characterization of large-scale shock-wave reformation *(Sep '21 - Nov '22)*

- Investigated generation of turquoise H_2 from CH_4 using shock waves via laser-absorption spectroscopy-based speciation & SEM imaging, enabling almost complete carbon and H_2 tracking during pyrolysis
- Identified operating conditions and time scales required for viably generating H_2 in commercial reactors

Field-deployable laser sensor for extreme environments *(Jan '21 - Oct '21)*

- Designed a **CAD-guided two-color differential absorption diagnostic** utilizing ICLs and kinematic mounts for crank angle-resolved measurements (40kS/s) of biofuel blend vapors in a race car engine
- Implemented an **intensity-modulation spectroscopy sensing scheme** to reject low-frequency noise

Multi-wavelength, ultra-fast diagnostic for gas-phased sensing *(Jan '21 - Sep '21)*

- Utilized **dual-comb spectroscopy** with detuned **quantum cascade lasers**, an interferometry technique for simultaneous speciation and thermometry during CH_4 pyrolysis at 5MHz between $1270-1315\text{cm}^{-1}$

SELECTED JOURNAL PUBLICATIONS

- **Biswas, P.**, Choudhary, R. and Hanson R.K., Multiwavelength Speciation in Pyrolysis of n-Pentane and Experimental Determination of the Rate Coefficient of $nC_5H_{12} = nC_3H_7 + C_2H_5$ in a Shock Tube, J. Phys. Chem. A, (2023) 127 (9), 2148-2160 (Published as part of The Journal of Physical Chemistry virtual special issue "Combustion in a Sustainable World: From Molecules to Processes")
- **Biswas, P.**, Choudhary, R. Panda A., Davidson, D.F. and Hanson R.K., A mid-IR laser absorption diagnostic for measuring formaldehyde at high pressures and its demonstration in shock tubes, Combust. Flame, (2022) 245, 112366
- Clees, S., Cha, D.H., **Biswas, P.**, Boddapati, V., Cassady, S.J., Strand, C.L., Hanson R.K., French, B., Gilmour, A. et al., A laser-absorption sensor for in situ detection of biofuel blend vapor in engine intakes, Proc. Combust. Inst. (2023), 39 (1), 1307-1316
- Pinkowski, N.H., **Biswas, P.**, Shao, J., Strand, C.L. and Hanson R.K., Thermometry and speciation for high-temperature and-pressure methane pyrolysis using shock tubes and dual-comb spectroscopy, Meas. Sci. Technol. 32, 125502

MENTORSHIP AND TEACHING EXPERIENCE

Teaching Assistant | *Optical Diagnostics and Spectroscopy Laboratory* *(Apr '24 - Jun '24)*

- Led the effort to provide graduate students with hands-on experience on advanced optical systems, laser alignment, integration of optical components, data acquisition and various spectroscopy techniques

Department Academic Mentor | *IIT Bombay, Student Mentorship Program* *(Apr '18 - Apr '19)*

- Mentored sophomores to help them navigate through their academic and co-curricular activities, earning a Special Mention for extraordinary efforts, **an accolade awarded to only 4 of 214 mentors**