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IOWA STATE UNIVERSITY

Center for Multiphase Flow Research and Education

March 2021 CoMFRE Newsletter

Message from the Director

As I write this from my work-from-home office, looking out the window as spring is starting to bloom, I recall how things were so different a year ago. I am hopeful that we will get to a “new normal” in the not-too-distant future. I do believe we will all be more cognizant of our health and going to work with a cold, with the goal of minimizing droplet transport when we sneeze, cough, talk, or even breathe. With spring allergies upon us, we also recognize that multiphase flows are abundant in nature as well as many manufacturing and transport processes, and all require further study. We at CoMFRE hope to be part of this study as we continue to add more faculty to our ranks in the ever-expanding reach of multiphase flow science.

Please stay healthy and safe,



Theodore (Ted) J. Heindel
Director, Center for Multiphase Flow Research and Education
Bergles Professor of Thermal Sciences



SAVE THE DATE: CoMFRE Annual Meeting, October 25-26, 2021

Mark your calendars for the 2021 CoMFRE Symposium and Member Meeting, October 25-26! Industry members will receive updates on shared research and meet with CoMFRE faculty and students to discuss future research and goals for

the center. COVID-19 conditions permitting, we also plan an open meeting with presentations, a poster competition, and ample opportunities for networking and interaction among industry representatives, faculty, graduate students and postdocs.

Additional information will be provided in future newsletters and posted on our [website](#) as plans are solidified.

CoMFRE Teaming with IJMF to Offer V-Seminar Series

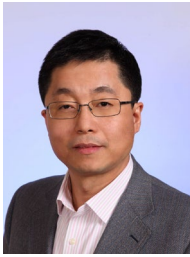
CoMFRE is teaming with the *International Journal of Multiphase Flow* (IJMF) to offer a virtual seminar series that will highlight leading multiphase flow researchers and recent IJMF authors. The goal is to promote communication among the multiphase flow community, which has suffered over the past year. The plan is to live cast the V-seminars with a Q&A session following the presentation. Since the speakers will come from all parts of the world, the presentation will also be recorded and be available for viewing on-demand if you cannot attend the live event. The first speaker will be Professor Andrea Prosperetti on April 20. Further details on the V-seminar series and how to register can be found at <https://www.journals.elsevier.com/international-journal-of-multiphase-flow/webinars/ijmf-spotlight-v-seminar-series>.

New CoMFRE Faculty Affiliates

[Ethan Secor](#) is a new Assistant Professor in Mechanical Engineering. His primary research focuses on advanced materials and manufacturing, specifically digital printing of electronic devices using aerosol jet and extrusion printing systems. This research includes efforts in printing system design, aerosol jet process science, process monitoring and control, materials and ink formulation, and flexible and hybrid device fabrication.



[Guowen Song](#) is a Professor and the Noma Scott Lloyd Chair in the Department of



Apparel, Event and Hospitality Management (AESHM). His academic interest is in coupled heat and moisture transfer, and aerosol particle penetration in textile-based porous structures related to PPE protective performance, heat stress, and human comfort. He combines modeling and laboratory hazard simulations to understand the mechanisms between the human body, the clothing/system, and the environment, with specific interactions involving hazards in various end-user scenarios from fire protection to contagion mitigation. These studies include the application of instrumented manikins and human subjects, advanced 3D body scanning technology, and motion analysis.

A full list of CoMFRE faculty affiliates can be found here:

<https://comfre.iastate.edu/faculty-2-2/page/1/>

CoMFRE and CoMFRE Affiliates in the News

Reducing Icing will Increase Wind Turbine Efficiency

Hui Hu, Martin C. Jischke Professor in Aerospace Engineering, leads a team studying how and where ice accumulates on rotating wind-turbine blades. Hu's team learned that icing can build up to almost 1 foot thick and reduce power production by up to 80%.



<https://www.news.iastate.edu/news/2021/03/04/windturbineicing>

CoMFRE researcher advances methods in additive manufacturing

Adarsh Krishnamurthy, associate professor of mechanical engineering and research associate for CoMFRE, recently published an article in the journal *Additive Manufacturing* which examines a new method for 3D printing directly using voxels. Krishnamurthy and his research team hope that the findings might become a more efficient method when 3D printing complex CAD models. <https://news.engineering.iastate.edu/2021/03/03/mechanical-engineering-researchers-develop-new-approach-for-additive-manufacturing/>

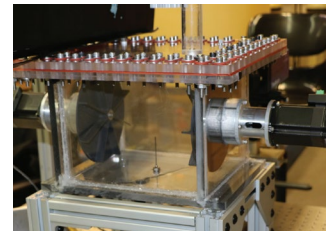
Collaboration with Homeland Security focuses on detecting biothreats

CoMFRE researchers **Todd Kingston**, assistant professor of mechanical engineering, **Pranav Shrotriya**, professor of mechanical engineering, along with Monica Lamm, associate professor of chemical and biological engineering and Marit Nilsen-Hamilton, professor of biophysics, biochemistry and molecular biology, are developing a sensor capable of detecting many biothreats, including COVID-19. The team is collaborating with the U.S. Department of Homeland Security on a biothreat sensor that is more flexible and portable than other current technologies.

<https://www.news.iastate.edu/news/2021/01/21/biothreatdetection>

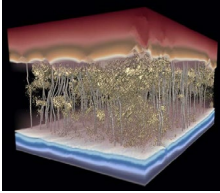
CoMFRE tackling a vexing droplet research issue with newly designed apparatus

CoMFRE researchers **R. Dennis Vigil**, professor of chemical and biological engineering, **Rodney Fox**, Anson Marston Distinguished Professor in Engineering and Hershel B. Whitney Professor, Global Initiatives, and **Michael Olsen**, professor of mechanical engineering, developed a new fluid flow apparatus for studying drop breakage. This novel instrumentation provides the ability to carefully control the fluid flow characteristics and give optical access for high-speed photography of breakup events and acquisition of 3D velocity fields. Data could give a much more in-depth understanding of the physics of drop breakage and support the development of new models for predicting and controlling breakage processes.



<https://news.engineering.iastate.edu/2021/01/13/isu-cbe-tackling...signed-apparatus/>

Researchers measure, model desalination membranes to maximize flow, clean more water



A research team including **Baskar Ganapathysubramanian** has used transmission electron microscopy and 3D computational modeling to quantify and visualize why some desalination membranes work better than others. Their work is featured on the cover of the Jan. 1, 2021, issue of the journal *Science*.

<https://www.news.iastate.edu/news/2020/12/30/desalination>

Applying mechanical engineering to pharmaceutical research

Michael Olsen, Professor of Mechanical Engineering, and **Dennis Vigil**, professor of Biological and Chemical Engineering, are leading a project to develop a computer model to assist Pfizer in predicting the behavior of ointment creams under the various manufacturing processes that they undergo, from emulsification in a homogenizer, to transport through pipes and valves in the manufacturing plant, to the packaging process.

<https://news.engineering.iastate.edu/2021/03/18/applying-mechanical-engineering-to-pharmaceutical-research/>

Recent Degrees Granted to Students Working on Multiphase Projects

- Stuart Barkley, PhD. "Electromagnetic control of energetic materials combustion," Advisor: **Travis Sippel**.
 - Marilyn C. McNamara, PhD. "Targeted Microfluidic Manufacturing for Functionalized Biomaterials: Encapsulation of Neural Cells into Conductive Alginate Microfibers," Advisor: **Nicole Hashemi**.
 - Soheila Shabaniverki, PhD. "Directed Assembly and Mechanics of Functional Polymer Composites," **Jaime Juárez**.
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Faculty Honors and Awards

Mechanical engineering associate professor **Nicole Hashemi** has been named a Fellow by the American Society of Mechanical Engineers (ASME). Of the more than 100,000 ASME Members, about 3,000 have attained the grade of Fellow. Hashemi's nominator cited both her research and teaching/mentoring contributions as reason for why she is worthy of this recognition. <https://news.engineering.iastate.edu/2021/03/08/hashemi-elected-a-fellow-of-american-society-of-mechanical-engineers/>



Recently Awarded Publicly-Funded Grants

Feel free to contact the PI directly if you have any questions on the projects below.

- “Acoustically activated release of organic liquids in porous media: a multiscale experimental investigation using laser-based optical diagnostics”; **Jaime Juárez** and **Michael Olsen**; Funding Agency: NSF; New Funding Amount: \$307,056.
- “X-ray imaging of multiphase flows of interest to ONR”; **T.J. Heindel**; Funding Agency: Office of Naval Research; New Funding Amount: \$50,000.
- “Detection of biothreats in near real time with a multiplexed aptasensor”; Marit Nilsen-Hamilton, **Todd Kingston**, **Pranav Shrotriya**, Monica Lamm, and Wendy Maury; Funding Agency: Department of Homeland Security; New Funding Amount: \$333,332.

Recent Journal Publications

Note that CoMFRE affiliates are identified by **bold** names.

- Aliseda, A., and **T.J. Heindel**, “X-ray flow visualization in multiphase flows,” *Annual Review of Fluid Mechanics*, 53:543-567, 2021. <https://doi.org/10.1146/annurev-fluid-010719-060201>
- Alméras, E., F. Risso, O. Masbernat, and **R.O. Fox**, “Statistics of velocity fluctuations in a homogeneous liquid fluidized bed,” *Physical Review Fluids* **6**, 034301, 2021. <https://doi.org/10.1103/PhysRevFluids.6.034301>

- Barkley, S.J., J.E. Lynch, E.J. Miklaszewski, J.M. Dilger, W.F. Crespo, **J.B. Michael, S. Subramaniam**, and **T.R. Sippel**, “Microwave-assisted modulation of light emission intensity in alkali-pyrotechnic plumes,” *Combust Flame* 225, 406–16, 2021.
<https://doi.org/10.1016/j.combustflame.2020.11.005>
- Clarke, G.A., B.X. Hartse, A.E. Niaraki Asli, M. Taghavimehr, N. Hashemi, M.A. Shirsavar, R. Montazami, N. Alimoradi, V. Nasirian, L.J. Ouedraogo, **N.N. Hashemi**, “Advancement of Sensor Integrated Organ-on-Chip Devices,” *Sensors* 21:1367, 2021. <https://doi.org/10.3390/s21041367>
- Culp, T.E, K. Biswajit, K.P. Brickey, M. Geitner, T.J. Zimudzi, J.D. Wilbur, S.D. Jons, A. Roy, Mou Paul, **B. Ganapathysubramanian**, A.L. Zydney, M. Kumar, and Enrique D. Gomez, “Nanoscale control of internal inhomogeneity enhances water transport in desalination membranes,” *Science* 371, 6524:72-75, 2021. <https://doi.org/10.1126/science.abb8518>
- Ilgun, A., **A. Passalacqua**, and **R.O. Fox**, “Solution of the first-order conditional moment closure for multiphase reacting flows using quadrature-based moment methods,” *Chemical Engineering Journal* **405**, 127020, 2021. <https://doi.org/10.1016/j.cej.2020.127020>
- Ilgun, A., X. Hu, **A. Passalacqua**, **R.O. Fox**, F. Bertola, M. Milosevic, and F. Visscher, “CFD simulations of stirred-tank reactor for gas-liquid and gas-liquid-solid systems using OpenFOAM,” *International Journal of Chemical Reactor Engineering*, 10.1515/ijcre-2019-0229, 2021.
<https://doi.org/10.1515/ijcre-2019-0229>
- Nadeem, H., **S. Subramaniam**, K. Sinha, and **T.J. Heindel**, “Characterization of intruder particle motion in a bladed mixer,” *Powder Technology*, 381:440-450, 2021.
<https://doi.org/10.1016/j.powtec.2020.12.002>
- Pillers, R.A., and **T.J. Heindel**, “Dynamic Visualization of Hydrate Formation using X-ray Imaging,” *Journal of Petroleum Science and Engineering*, 200, Paper 108334, 2021. <https://doi.org/10.1016/j.petrol.2020.108334>
- Shabaniverki, S., S. Xie, J. Ren, and **J.J. Juárez**, “Soft Ferrofluid Actuator Based on 3D-Printed Scaffold Removal,” 3-D Printing and Additive Manufacturing, online 4 Feb 2021. <https://doi.org/10.1089/3dp.2020.0012>
- Williams, K., **N.N. Hashemi**, M Riddley, G.A. Clarke, N. Igwe, D. Elnagib, and Reza Montazami, “Progress of graphene devices for electrochemical biosensing in electrically excitable cells.” Progress in

Biomedical Engineering 3 (2), 022003, 2021. <https://doi.org/10.1088/2516-1091/abe55b>

- Wrede, A.H., J. Luo, R. Montazami, A. Kanthasamy, **N.N. Hashemi**, “How do neuroglial cells respond to ultrasound induced cavitation?” AIP Advances 11 (1), 015314, 2021. <https://doi.org/10.1063/5.0034936>

Recent Conference Publications

- **J. Lee**, S. Katamreddy, M. SanSoucie, Y. C. Cho, S. Lee, M. Watanabe, T. Ishikawa, and G. W. Lee, “Containerless Materials Processing for Materials Science on Earth and in Space,” Materials Processing Fundamentals 2021, In Press.
- A. Rabe, M. Kahnwale, **B. Ganapathysubramanian**, M. SanSoucie, and **J. Lee**, “Computational Fluid Dynamics Modeling of Damped Oscillations of Molten Metal Droplets,” TMS Annual Meeting, 2021, Virtual.

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