



# pig MONTHLY

process intensification group | <http://pig.ncl.ac.uk> | [www.pinetwork.org](http://www.pinetwork.org)

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## **COVID-19 Impact Statement**

COVID has significantly affected everyone's lives over the past 7 months, and resultantly our way of working has needed to change in response. Like most organisations around the country, Newcastle University has worked to make sure that teaching and research can be conducted as COVID-securely as possible. Some of the specific measures include:

- Minimising the number of people on the campus at any one time by maximising home working where possible
- Using a blended learning approach to minimise face-to-face contact
- Physical controls for building and research labs, such as: room occupancy limits to maintain 2m+ social distancing, one-way systems, signage, hand sanitisation points, enhanced cleaning regimes, and campus/building occupancy monitoring

Further information about Newcastle University's approach can be found [here](#).

For the PI Group's research, this meant a significant reduction in lab-based research activity during the 2<sup>nd</sup> and 3<sup>rd</sup> quarters of 2020. However, we are now pleased to confirm that PhD students and senior researchers are able to perform essential research activity in our labs. We continue to monitor the situation closely, and we are confident that we can continue to meet our research goals and commitments with collaborators and project partners around the UK and overseas.

## Upcoming Virtual Conferences

Some of our regular conference series have adopted virtual formats in order to maintain our ability to network and collaborate. If anyone in PIG knows of additional virtual conferences not mentioned here that may be of interest, please notify [jona-than.mcdonough@ncl.ac.uk](mailto:jona-than.mcdonough@ncl.ac.uk) so that these can be included in future newsletters.

- [Scale-up of chemical processes](#), October 19-21, 2020
- [2020 Virtual AIChE Annual Meeting](#), November 16-20, 2020
- [14th Mediterranean Congress of Chemical Engineering](#), November 16-20, 2020
- [Hazards 30](#), November 26-27, 2020

## New Research Funding

- **ICED - Intensified Cooling of Electronic Devices**  
EPSRC New Investigator Award  
PI: Dr Richard Law  
Value: ~£300k  
Start Date: ~1st Feb
- **Design and Fabrication of Industrial Scale Rotating Packed Bed Adsorber and Regenerator**  
Transitional Energy Research Centre  
PI: Dr Jon Lee  
Value: ~£290k  
Aug 2020—Aug 2021
- **BioSPRINT: Biorefining of Sugars via Process Intensification**  
Horizon 2020  
PIs: Dr Fernando Russo Abegão, Dr Kamelia Boodhoo  
Value: £717k  
June 2020—May 2024
- **Plasma agglomerator for cleaning up effluents**  
EPSRC Impact Acceleration Award  
Researchers: Prof Adam Harvey, Dr Kui Zhang  
Value: ~£45k

## Virtual Conference Attendance

- Toyoda R., Russo Abegão F., Gill S. and Glassey J. (2020) [Perceptions of Professional Chemical Engineers Towards Immersive Virtual Reality in Health and safety Training](#), The 8<sup>th</sup> European Conference in Education 2020, 17<sup>th</sup>-19<sup>th</sup> of July 2020, London (Virtual Venue), UK
- Udeozor C., Russo Abegão F., and Glassey J. (2020) [An Evaluation of the Use of Serious Games for Chemical Engineering Education](#), 14<sup>th</sup> European Conference in Games-Based Learning, Brighton (Virtual Venue), UK.

## Conference Attendance

Becoming the first climate-neutral continent by 2050 is an ambitious goal which requires ambitious measures. Energy efficiency and renewable energy are at the centre of this roadmap for making the EU's economy sustainable. The World Sustainable Energy Days (WSED) is a 3 day event that offers 6 dedicated conferences (including the European Energy Efficiency Policy Conference, the European Pellet Conference, the Industrial Energy Efficiency Conference and the Smart E-Mobility Conference), technical visits and a major tradeshow with 1,600 exhibitors. Adam attended the most recent [WSED and Expo](#) in Wels, Austria, 4-5<sup>th</sup> March, and gave a talk on the use of the plasma agglomerator for reducing particulate emissions from biomass boilers:

## Other Information

- Full contact details and research profiles for the PI group members can be found at the website: <http://pig.ncl.ac.uk>
- For enquires about collaborations or PhD study, see the website: <http://pig.ncl.ac.uk>
- If anyone would like to contribute any articles, or if anyone has any ideas regarding the newsletter please contact Jonathan McDonough: [jonathan.mcdonough@ncl.ac.uk](mailto:jonathan.mcdonough@ncl.ac.uk)



## PIG News

- We now have a Twitter profile: [@NewcastlePIG](#) - follow to receive the latest updates and activities from the group. PhD students and researchers in the group should use this as an opportunity to promote their research
- Congratulations to **Chioma Udeozor** who received the best poster award at the Virtual 14th European Conference on Game-Based Learning. The poster was titled: *Evaluation of the use of a Series Game for Chemical Engineering Education*
- Congratulations to **Sahr Sana** who passed her PhD viva with minor corrections on 10th March 2020
- Welcome to the following new PhD students:
  - ◇ **Tom Carr** will be working on the intensification of hemicellulose purification and polymerization into biorenewable resins with Dr Kamelia Boodhoo and Dr Fernando Russo Abegão
  - ◇ **Israa Kalifa** will be working on non-thermal plasma reactions of CO<sub>2</sub> with Prof Adam Harvey and Dr Kui Zhang
  - ◇ **Richard McNeill** will be working with Prof Adam Harvey, Dr Fernando Russo Abegão, and Dr Jonathan McDonough on 3D printing and flow chemistry (CASE Award with Sterling Pharma Solutions)
  - ◇ **Maggie Zhang** will be working with Prof Adam Harvey and Dr Kui Zhang on CO<sub>2</sub> plasma chemistry
- Welcome to the following visiting postdoctoral researchers from the University of Technology, Iraq:
  - ◇ **Dr Shurooq Al Humairi** will be working on the direct production of biodiesel from oleaginous solid feedstocks
  - ◇ **Dr Farah Al Sudani** will be working on various CO<sub>2</sub> reactions in plasma
- **Dr Fernando Russo Abegão** and **Dr Maria Vicevic** delivered a talk on “*Embedding Digital Tools in Chemical Engineering Labs*” on the 30<sup>th</sup> of July 2020 as part of the 2<sup>nd</sup> Workshop on Hybrid Laboratories organised by the IChemE Education Special Interest Group
- PIG meetings will resume from 16<sup>th</sup> October 2020 so that we can return a sense of our normal research community and support. The format is as follows: Fridays @ 12:00; Zoom; speakers will prepare a maximum 15 min talk (which can be live or pre-recorded); 10 min for questions. Etiquette: please try to attend every week; everyone will mute their mics while the speaker presents; questions will be asked during the Q&A via the chat or by virtually raising hands. We look forward to seeing everyone again.

# Announcements

- Prof Adam Harvey attended a meeting of the European Working Group on PI a couple of weeks ago. The discussion was largely about conferences, particularly the "IPIC" series, which is organised by the group. The previous IPIC was held in Leuven Belgium in 2019, and the plan as discussed then was for the next IPIC event to be in Beijing in May 2021. However, this has now been postponed to May 2022. The next WCCE originally planned to take place in Argentina 2021 has also been postponed to June 2022. There will however be PI sessions in next year's ECCE, Berlin 19-23 September. This conference, at time of writing, is going ahead, "in person".
- Two virtual early career researcher away days are taking place on 7th and 14th October (both from 1pm to 3.30pm BST). The virtual sessions will have a focus on communicating research, featuring expertise from those who regularly (and successfully) broadcast their research, and will also include input from stakeholders that typically receive such research communications. You can sign up for the event [here](#)
- The MatCoRe group currently has two open positions:
  - ◊ **PDRA** (Fixed Term for 18 months, Full Time) - project will deliver a new low-carbon hydrogen production system at small scale; the role will involve scaling up the process from existing lab scale equipment to a small demonstration reactor unit with the aim to exploit the technology commercially.
  - ◊ **PhD** (3.5 years) - project will involve the design and synthesis of new high-temperature ceramic membranes and permeation testing in a world-leading gas separation lab. Supervisors: Dr G Mutch, Prof I Metcalfe. Funding for Europeans/UK Students only
- The World Society of Sustainable Energy Technologies (WSSET) have announced a number of new awards, some with cash prizes, open to PhD students and early career researchers. All award winners will receive an Award Certificate and will be invited to participate in the SET 2021 conference in Istanbul, Turkey. More information on each award and conditions can be found on the [WSSET Awards page](#).
- Prof David Reay will soon be circulating data on the next round of UK National Heat Transfer Committee student awards (PhD, MEng, and MSc categories), to be awarded in September 2021 at the UK Heat Transfer Conference in Manchester, UK. The 2019 PhD winner was from Mechanical Engineering at Newcastle University.
- The Micro and Nano Flows (MNF) Conference that was originally supposed to take place in London 2020 has been postponed because of the coronavirus outbreak. The conference organisers will inform colleagues once new dates have been decided.
- The International Symposium on Green Chemistry (ISGC) has also been postponed because of the current pandemic situation. The next ISGC will take place from 16-20<sup>th</sup> May 2022 in La Rochelle, France. The invited plenary and keynote speakers remain unchanged.



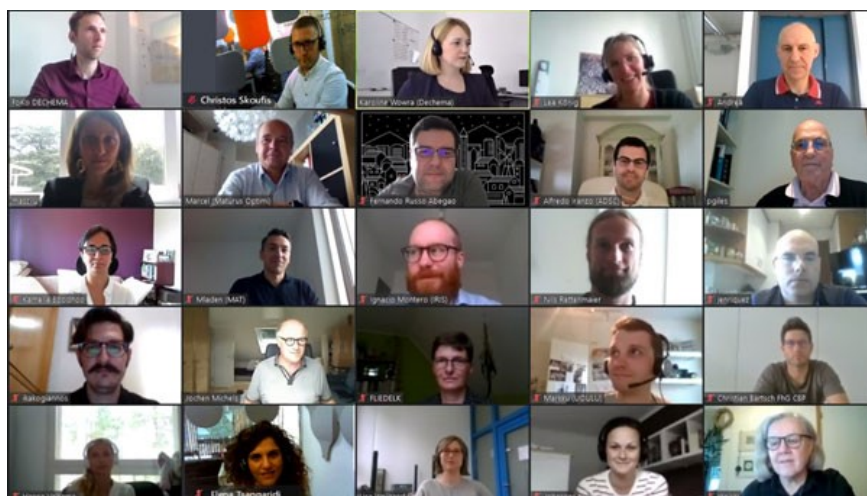


## BioSPRINT

### From Sugars to Biorenewable Resins via Process Intensification

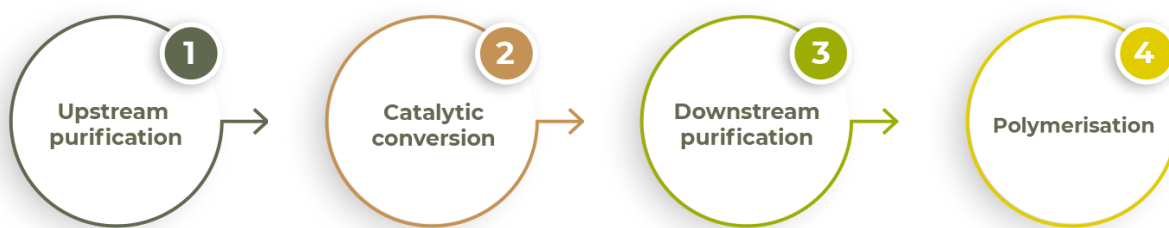
*Dr Fernando Russo Abegão, Dr Kamelia Boodhoo*

The online kick-off meeting for the project **BioSPRINT “Biorefining of Sugars via Process Intensification”** was held on the 18th June 2020. The BioSPRINT consortium consists of 13 partners from 8 European countries, and is coordinated by DECHEMA e.V. and technically managed by Newcastle University. The project consortium combines researchers, technology providers, industrial actors, end-users and support organisations and provides a cross sectorial and transdisciplinary opportunity for all stakeholders to collaborate and share technical knowledge and market expertise. The PI Group at Newcastle is represented in this project by Dr Fernando Russo Abegão and Dr Kamelia Boodhoo.



*Figure 1. Some of the BioSPRINT members and the EU Project Officer during the project KOM.*

BioSPRINT aims to develop and validate process intensification methods to improve purification and conversion of the hemicelluloses fraction of lignocellulosic biomass. Thus, the transformation into new bio-based resins is enabled and fossil-based polymers can be substituted. The overall goal is striving towards ‘zero-waste’ biorefining operations by concentrating on technologies which can intensify processing methods and applying an integrated biorefinery concept. This will lead to an increased resource efficiency and thus reduction of energy resources and greenhouse gas emissions.



*Figure 2. BioSPRINT key activity areas*

The project will develop and validate an intensified and integrated purification strategy leveraging innovative anti-solvent precipitation and membrane separation methods, novel intensified and integrated catalytic processes for dehydration of C5 and C6 hemicelluloses sugars into monomers, extractive-reaction methods to isolate the reaction products from the reaction medium *in situ*, heterogeneous catalysts and an intensified polymerisation process for furan-based derivatives. Cross-cutting activities will cover process simulation and optimisation, an integrated Lifecycle sustainability assessment, standardisation, dissemination and exploitation activities.

You can follow project updates via the project website at: <https://www.biosprint-project.eu>

BioSPRINT has received funding from the Bio Based Industries Joint Undertaking (BBI JU) under the European Union's Horizon 2020 research and innovation programme under grant agreement No 887226. The project duration is four years, until May 2024.



## ***New Publications (since Jan 2020)***

Abdul Rahim M.A., Phan A.N., Harvey A.P. **Intensification of epoxidation of vegetable oils using a continuous mesoscale oscillatory baffled reactor.** Journal of Advanced Manufacturing and Processing 2 (3) (2020) e10041

Al-Abduly A., Christensen P., Harvey A. **The characterization of a packed bed plasma reactor for ozone generation.** Plasma Sources Science and Technology 29 (3) (2020) 035002

Al-Saadi L.S., Eze V.C., Harvey A.P. **A techno-economic analysis based upon a parametric study of alkali-catalysed biodiesel production from feedstocks with high free fatty acid and water contents.** Biofuels (2020) 1-13

Chen Q., Li R., Xiu W.Z., Zheng G., Zivkovic V., Yang H. **Dynamics of irregular particles in the passive layer under the slumping regime.** Powder Technology 372 (2020) 32-39

Chen Q., Yang H., Li R., Xiu W.Z., Han R., Sun Q.C., Zivkovic V. **Compaction and dilatancy of irregular particles avalanche flow in rotating drum operated in slumping regime.** Powder Technology 364 (2020) 1039-1048

Corrigan J., Zhang J. **Integrating Dynamic Slow Feature Analysis with Neural Networks for Enhancing Soft Sensor Performance.** Computers & Chemical Engineering 139 (2020) 106842

Díaz V.H.G., Willis M.J., von Stosch M., Tost G.O., Prado-Rubio O. **Assessing the energy requirements for butanol production using fermentation tanks-in-series operated under vacuum.** Renewable Energy 160 (2020) 1253-1264

Duong L.T., Phan A.N. **Intensification of hydrodeoxygenation of liquid derived from pyrolysis: guaiacol as model compound.** Chemical Engineering Journal 402 (2020) 125793

González-Balderas R.M., Velásquez-Orta S.B., Ledesma M.T.O. **Biorefinery process intensification by ultrasound and ozone for phosphorus and biocompounds recovery from microalgae.** Chemical Engineering and Processing-Process Intensification 153 (2020) 107951

Gonzalez-Balderas R.M., Velasquez-Orta S.B., Valdez-Vazquez I., Orta Ledesma M.T. **Intensified recovery of lipids, proteins, and carbohydrates from wastewater-grown microalgae *Desmodesmus* sp. by using ultrasound or ozone.** Ultrasonics Sonochemistry 62 (2020) 104852

González-Balderas R.M., Velásquez-Orta S.B., Valdez-Vazquez I., Orta Ledesma M.T. **Sequential pretreatment to recover carbohydrates and phosphorus from *Desmodesmus* sp. cultivated in municipal wastewater.** Water Science and Technology (2020) In-Press. DOI: 10.2166/wst.2020.404



González-Gálvez O.D., Bravo I.N., Cuevas-García R., Velásquez-Orta S.B., Harvey A.P., Caero L.C., Orta Ledesma M.T. **Bio-oil production by catalytic solvent liquefaction from a wild microalgae consortium.** Biomass Conversion and Biorefinery (2020) 1-13

Harris J., Zhang K., Phan A.N. **Cold plasma assisted decomposition of alcohols.** Chemical Engineering and Processing-Process Intensification 153 (2020) 107985

Harris J., Zhang K., Phan A.N. **Cold plasma assisted deoxygenation of liquid phase glycerol at atmospheric pressure.** Chemical Engineering Journal 393 (2020) 124698

Ikwebe J., Harvey A.P. **Fuel ethanol production from cassava (*Manihot esculenta* Crantz) in an oscillatory baffled reactor.** Biofuels 11 (4) (2020) 451-457

Kong P., Wang B.D., Wang P., Zivkovic V., Zhang J.Q. **Improved spatial filtering velocimetry and its application in granular flow measurement.** Chinese Physics B 29 (7) (2020) 074201

Laing H., O'Malley C., Browne A., Rutherford T., Baines T., Willis M.J. **Development of a biogas distribution model for a wastewater treatment plant: a mixed integer linear programming approach.** Water Science and Technology (2020) In-Press. DOI: 10.2166/wst.2020.363

Liu K., Zhang J. **Nonlinear process modelling using echo state networks optimised by covariance matrix adaption evolutionary strategy.** Computers & Chemical Engineering 135 (2020) 106730

McDonough J.R. **A perspective on the current and future roles of additive manufacturing in process engineering, with an emphasis on heat transfer.** Thermal Science and Engineering Progress 19 (2020) 100594

McDonough J.R., Law R., Reay D.A., Groszek D., Zivkovic V. **Miniaturisation of the toroidal fluidization concept using 3D printing.** Chemical Engineering Research and Design 160 (2020) 129-140

Muster-Slawitsch B., Buchmaier J., Brunner C., Nidetzky B., Gudimich R.K., Harvey A.P., Phan A.N. **Oscillating flow bioreactors: An enabling technology for sustainable biorefining operations?** Journal of Advanced Manufacturing and Processing 2 (2) (2020) e10046

do Nascimento O.L., Reay D.A., Zivkovic V. **Solid Circulating Velocity Measurement in a Liquid-Solid Micro-Circulating Fluidised Bed.** Processes 8 (9) (2020) 1159

Palmer J., O'Malley C.J., Wade M.J., Martin E.B., Page T., Montague G.A. **Opportunities for process control and quality assurance using online NIR analysis to a continuous wet granulation tableting line.** Journal of Pharmaceutical Innovation 15 (1) (2020) 26-40

Rivas D.F., Boffito D.C., Faria-Albanese J., Glassey J., Afraz N., Akse H., Boodhoo K.V.K., *et al.* **Process intensification education contributes to sustainable development goals. Part 1.** Education for Chemical Engineers 32 (2020) 1-14

Rivas D.F., Boffito D.C., Faria-Albanese J., Glassey J., Cantin J., Akse N.A.H., Boodhoo K.V.K., *et al.* **Process intensification education contributes to sustainable development goals. Part 2.** Education for Chemical Engineers 32 (2020) 15-24

Saleem F., Harris J., Zhang K., Harvey A. **Non-thermal plasma as a promising route for the removal of tar from the product gas of biomass gasification–A critical review.** Chemical Engineering Journal 382 (2020) 122761

Taylor C.J., Booth M., Manson J.A., Willis M.J., Clemens G., Taylor B.A., Chamberlain T.W., Bourne R.A. **Rapid, Automated Determination of Reaction Models and Kinetic Parameters.** Chemical Engineering Journal (2020) 127017

Valeriano González M.T., Orta Ledesma M.T., Velasquez-Orta S.B., Ramirez I.M. **Harvesting microalgae using ozone-air flotation for recovery of biomass, lipids, carbohydrates, and proteins.** Environmental Technology (2020) 1-11

Wang S.S., Li R., Chen Q., Zheng G., Zivkovic V., Yang H. **Experimental measurement of granular flow layers in the chute.** Powder Technology 376 (2020) 22-30

Willis M.J., Wright A.R., Bramfitt V., Díaz V.H.G. COVID-19: **Mechanistic model calibration subject to active and varying non-pharmaceutical interventions.** medRxiv (2020) DOI: 10.1101/2020.09.10.20191817

Willis M.J., Díaz V.H.G., Prado-Rubio O.A., von Stosch M. **Insights into the dynamics and control of COVID-19 infection rates.** Chaos, Solitons & Fractals 138 (2020) 109937

Wrobel R., Scholes B., Hussein A., Law R., Mustaffar A., Reay D. **A metal additively manufactured (MAM) heat exchanger for electric motor thermal control on a high-altitude solar aircraft–Experimental characterisation.** Thermal Science and Engineering Progress 19 (2020) 100629

Zhao Z., Qin S., Wang D., Pu Y., Wang J.X., Saczek J., Harvey A., Ling C., Wang S., Chen J.-F. **Multi-stimuli-responsive liquid marbles stabilized by superhydrophobic luminescent carbon dots for miniature reactors.** Chemical Engineering Journal 391 (2020) 123478

Zhu C.H., Zhang J. **Developing Soft Sensors for Polymer Melt Index in an Industrial Polymerization Process Using Deep Belief Networks.** International Journal of Automation and Computing 17 (1) (2020) 44-54