CORNING

Advanced-Flow™ Reactors

AFR related publications

Issued: November 2020

AFR performance *

- A. Roibu, C. R. Horn, T. Van Gerven, S. Kuhn
  Photon Transport and Hydrodynamics in Gas-Liquid Flows
  Part 2: Characterization of Bubbly Flow in an Advanced-Flow Reactor
  WILEY-VCH Verlag GmbH & Co https://doi.org/10.1002/cptc.202000066 (2020)
  Topic: Photochemistry

- O. Lobet, A. Vizza
  SiC Advanced-Flow Reactors for Highly Corrosive Media
  Specialty Chemical Magazine, 36(08), 32-35 (2016)
  Topic: Silicon carbide description and characterization

- M.J. Nieves-Remacha, K.F. Jensen
  Mass transfer characteristics of ozonolysis in microreactors and Advanced-Flow reactors
  Journal of Flow Chemistry, 5 (3), pp. 160-165 (2015)
  Topic: Low Flow and G1 fluidic modules, gas/liquid mass transfer

- M.J. Nieves-Remacha, A.A. Kulkarni, K.F. Jensen
  OpenFOAM Computational Fluid Dynamic Simulations of Single-Phase Flows in an Advanced-Flow Reactor
  Industrial and Engineering Chemistry Research, 54 (30), pp. 7543-7553 (2015)
  Topic: G1 fluidic module, liquid flow, pressure drop, residence time distribution

- M.J. Nieves-Remacha, L. Yang, K.F. Jensen
  OpenFOAM Computational Fluid Dynamic Simulations of Two-Phase Flow and Mass Transfer in an Advanced-Flow Reactor
  Industrial and Engineering Chemistry Research, 54 (26), pp. 6649-6659 (2015)
  Topic: G1 fluidic module, liquid/liquid flow and mass transfer

- K.J. Wu, V. Nappo, S. Kuhn
  Hydrodynamic Study of Single- and Two-Phase Flow in an Advanced-Flow Reactor
  Industrial and Engineering Chemistry Research, 54 (30), pp. 7554-7564 (2015)
  Topic: G1 fluidic module, PIV (particle image velocimetry), liquid and gas/liquid flow

- M. Moreau, N. Di Miceli Raimondi, N. Le Sauze, M. Cabassud, C. Gourdon
  Pressure drop and axial dispersion in industrial millistructured heat exchange reactors
  Chemical Engineering and Processing, 95, pp. 54–62 (2015)
  Topic: G1 fluidic modules, pressure drop and residence time distribution

**Please note this publication list is provided for reference only and does not constitute an endorsement by Corning Incorporated of any particular publication, institution, author, product or method.*

- A. Woitalka, S. Kuhn, K.F. Jensen
  Scalability of mass transfer in liquid–liquid flow
  Chemical Engineering Science 116, 1-8 (2014)
  Topic: G1 and Low Flow fluidic modules, Liquid/Liquid flow and mass transfer

- M.J. Nieves-Remacha, A.A. Kulkarni, K.F. Jensen
  Gas-liquid flow and mass transfer in an Advanced-Flow reactor
  Industrial and Engineering Chemistry Research, 52 (26), pp. 8996-9010 (2013)
  Topic: G1 fluidic module, Gas/Liquid flow and mass transfer

- E.D. Lavric, C. Cerato-Noyerie
  Mass transfer in gas-liquid flow in Corning® Advanced-Flow™ reactors
  Chemical Engineering Transactions, 29, pp. 979-984 (2012)
  Topic: G1 fluidic module, gas/Liquid flow and mass transfer

- M.J. Nieves-Remacha, A.A. Kulkarni, K.F. Jensen
  Hydrodynamics of liquid-liquid dispersion in an advanced-flow reactor
  Industrial and Engineering Chemistry Research, 51 (50), pp. 16251-16262 (2012)
  Topic: G1 fluidic module, liquid/liquid flow and mass transfer

- J. Jorda, A. Vizza
  From laboratory to production: A seamless scale-up
  Speciality Chemicals Magazine, Nov., pp. 19-21, (2012)
  Topic: scale-up

- M.S. Chivilikhin, L.L. Kuandykov, C. Cerato-Noyerie, P. Woehl, E.D. Lavric
  Residence Time Distribution in Corning AFR. Experiment and modeling
  Chemical Engineering Transactions, 25, pp. 791-796 (2011)
  Topic: G1 and Low Flow fluidic modules, residence time distribution

- F. Zhang, C. Cerato-Noyerie, P. Woehl, E.D. Lavric
  Intensified liquid/liquid mass transfer in Corning® Advanced-Flow™ Reactors
  Chemical Engineering Transactions, 24, pp. 1369-1374 (2011)
  Topic: Low Flow fluidic module, liquid/liquid mass transfer

- M.S. Chivilikhin, V. Soboleva, L. Kuandykov, P. Woehl, E.D. Lavric
  CFD analysis of hydrodynamic and thermal behaviour of Advanced-Flow™ reactors
  Chemical Engineering Transactions, 21, pp. 1099-1104 (2010)
  Topic: G1 fluidic module, velocity field, pressure drop and heat transfer

- E.D. Lavric, P. Woehl
  Advanced-Flow™ glass reactors for seamless scale-up
  Chemistry Today, 27 (3), pp. 45-48 (2009)
  Topic: G1 and G2 fluidic modules, mixing, pressure drop, residence time distribution, heat transfer coefficient

- E.D. Lavric
  Thermal performance of Corning glass microstructures, Heat Transfer and Fluidic Flow in Microscale III 2008

Photochemistry applications*

- A. Mata, D. N. Tran, U. Weigl, J.D. Williams, O. Kappe
  Continuous flow synthesis of arylhydrazines via nickel/photoredox coupling of tert-butyl carbazate with aryl halides
  Royal Society of Chemistry DOI:10.1039/d0cc06787c (2020)

- A. Steiner, P. M.C. Roth, F. J. Strauss, G. Gauron, G. Tekautz, M. Winter, J.D. Williams, O. Kappe
  Multikilogram per Hour Continuous Photochemical Benzylic Brominations Applying a Smart Dimensioning Scale-up Strategy
  Organic Process Research & Development DOI:10.1021/acs.oprd.0c00239 (2020)

- P. Bianchi, G. Petit, J. C. Monbaliu
  Scalable and robust photochemical flow process towards small spherical gold nanoparticles
  Reaction Chemistry Engineering, Accepted Manuscript, https://doi.org/10.1039/D0RE00092B (2020)

- C. R. Horn, S. Gremetz
  A method to determine the correct photocatalyst concentration for photooxidation reactions conducted in continuous flow reactors
  Beilstein Journal of Organic Chemistry, 16, 871-879 (2020)

- N. Emmanuel, P.Bianchi, J. Legros, J. M. Monbaliu
  A safe and compact flow platform for the neutralization of a mustard gas simulant with air and light
  Green Chemistry, DOI: 10.1039/D0GC01142H (2020)

- A. Steiner, J.D. Williams, O. de Frutos, J.A. Rincón, C. Mateos , C.O. Kappe
  Continuous photochemical benzylic bromination using in situ generated Br2: process intensification towards optimal PMI and throughput
  Green Chemistry,22, pp. 448-454, (2020)

- I. Abdiaj, C. R. Horn, J. Alcazar
  Scalability of Visible-Light-Induced Nickel Negishi Reactions: A Combination of Flow Photochemistry, Use of Solid Reagents, and In-Line NMR Monitoring
  The Journal of Organic Chemistry 84, 4748–4753 (2019)

- A. Steiner, J.D. Williams, J. A Rincón, O. de Frutos, C. Mateos, C. O. Kappe
  Implementing Hydrogen Atom Transfer (HAT) Catalysis for Rapid and Selective Reductive Photoredox Transformations in Continuous Flow
  European Journal of Organic Chemistry, 25, 5807-5811. DOI: 10.1002/ejoc.201900952 (2019)

- R. Lebl, D. Cantillo, C.O. Kappe
  Continuous generation, in-line quantification and utilization of nitrosyl chloride in photonitrosation reactions
  Reaction Chemistry & Engineering, 4 (4), pp. 738-746 (2019)

- J.D. Williams, M. Nakano, R. Gérardy, J.A. Rincón, Ó. de Frutos, C. Mateos, J.C.M. Monbaliu C.O. Kappe
  Finding the Perfect Match: A Combined Computational and Experimental Study toward Efficient and Scalable Photosensitized [2 + 2] Cycloadditions in Flo
  Organic Process Research & Development, 23 (1), pp. 78-87 (2019)

**Please note this publication list is provided for reference only and does not constitute an endorsement by Corning Incorporated of any particular publication, institution, author, product or method.*

- X.-F. Tang, J.-N. Zhao, Y.-F. Wu, Z.-H. Zheng, S.-H. Feng, Z.-Y. Yu, G.-Z. Liu, Q.-W. Meng
  Enantioselective photooxygenation of β-dicarbonyl compounds in batch and flow photomicroreactors
  Organic & Biomolecular Chemistry, 17, 7938-7942, (2019)

- Cristian Rosso, Jason D. Williams, Giacomo Filippini, Maurizio Prato, C. Oliver Kappe
  Visible-Light-Mediated Iodoperfluoroalkylation of Alkenes in Flow and Its Application to the Synthesis of a Key Fulvestrant Intermediate
  Organic Letters, 21 (13), 5341-5345, (2019)

- Anhua Hu, Yilin Chen, Jing-Jing Guo, Na Yu, Qing An, Zhiwei Zuo
  Cerium-catalyzed Formal Cycloaddition of Cycloalkanols with Alkenes through Dual Photoexcitation
  J. Am. Chem. Soc., 140, 42, pp 13580-13585, (2018)

- Y. Chen, O. de Frutos, C. Mateos, J.A. Rincon, D. Cantillo, C.O. Kappe
  Continuous Flow Photochemical Benzylic Bromination of a Key Intermediate in the Synthesis of a 2-Oxazolidinone
  ChemPhotoChem 2 (2018)

- G. Gauron, J. Ao, S. Gremetz, C.R. Horn
  Powerful scalable photochemistry: The efficient use of light
  Chemistry Today, 36 (4), pp. 12-15 (2018)

- Anhua Hu*, Jing-Jing Guo*, Hui Pan, Zhiwei Zuo
  Selective functionalization of methane, ethane, and higher alkanes by cerium photocatalysis
  Science, Vol. 361, Issue 6403, pp. 668-672 (2018)

- R. Gérardy, M. Winter, C.R. Horn, A. Vizza, K. Van Hecke, J-C.M. Monbaliu
  Continuous-flow preparation of γ-butyrolactone scaffolds from renewable fumaric and itaconic acids under photosensitized conditions
  Organic Process Research and Development 21 (12), pp. 2012-2017 (2017)

- N. Emmanuel, C. Mendoza, M. Winter, C.R. Horn, A. Vizza, L. Dreesen, B. Heinrichs, J-C.M. Monbaliu
  Scalable Photocatalytic Oxidation of Methionine under Continuous-Flow Conditions
  Organic Process Research and Development 21 (9), pp 1435–1438 (2017)

- S. Elgue, T. Aillet, K. Loubiere, A. Conté, O. Dechy-Cabaret, L. Prat, C.R. Horn, O. Lobet, S. Vallon
  Flow photochemistry: A meso-scale reactor for industrial applications
  Chemistry Today, 33 (5), pp. 58-61 (2015)

Other applications*

- D.M. Le, Bougrine A.J., O. Duclos, V. Pasquet, H. Delalu
  A new strategy for the synthesis of monomethylhydrazine using the Raschig process. 2: Continuous synthesis of stoichiometric monochloramine using the microreactor technology
  Reaction Kinetics, Mechanisms and Catalysis (2020)

- V.H Kassin, T. Toupy, G. Petit, P. Bianchi, E. Salvadeo, J-C M. Monbaliu
  Metal-free hydroxylation of tertiary ketones under intensified and scalable continuous flow conditions
  Journal of Flow Chemistry 10, 167–179 (2020)

- R. Gérardy, J. Estager, P. Luis, D. P. Debecker, J-C. M. Monbaliu
  Versatile and scalable synthesis of cyclic organic carbonates under organocatalytic continuous flow conditions
  Catalysis Science & Technology, 9, pp. 6841-6851, (2019)

- R. Morodo, R. Gérardy, G. Petit, J-C. M. Monbaliu
  Continuous flow upgrading of glycerol toward oxiranes and active pharmaceutical ingredients thereof
  Green Chemistry, 21, pp. 4422-4433, (2019)

- V.-E. Kassin, R. Gérardy, T. Toupy, D. Collin, E. Salvadeo, F. Toussaint, K. Van Hecke, J-C. M. Monbaliu
  Expedient Preparation of Active Pharmaceutical Ingredient Ketamine under Sustainable Continuous Flow Conditions
  Green Chemistry, 21, pp. 2952-2966, (2019)

- Z. Wang, R. Gérardy, G. Gauron, C. Damblon, J-C.M. Monbaliu
  Solvent-free organocatalytic preparation of cyclic organic carbonates under scalable continuous flow conditions
  Reaction Chemistry & Engineering, 4 (1), pp. 17–26 (2019)

- S.C. Born, C.E.R. Edwards, B. Martin, K.F. Jensen
  Continuous, on-demand generation and separation of diphenylphosphoryl azide
  Tetrahedron 74 (25), pp. 3137-3142 (2018)

- S. Suranani, Y. Maralla, S.M. Gaikwad, S.H. Sonawane
  Process intensification using Corning® Advanced-Flow™ reactor for continuous flow synthesis of biodiesel from fresh oil and used cooking oil
  Chemical Engineering & Processing: Process Intensification, 126, pp. 62–73 (2018)

- P.L. Suryawanshi, S.H. Sonawane, B.A. Bhanvase, M. Ashokkumar, M.S. Pimplapure, P.R. Gogate
  Synthesis of iron oxide nanoparticles in a continuous flow spiral microreactor and Corning® Advanced-Flow™ reactor
  Green Processing and Synthesis, 7 (1), pp. 1-11 (2018)

- C. Penverne, B. Hazard, C. Rolando, M. Penhoat
  Scale-up Study of Benzoic Acid Alkylation in Flow: From Microflow Capillary Reactor to a Milliflow Reactor
  Organic Process Research and Development 21 (11), pp. 1864-1868 (2017)

**Please note this publication list is provided for reference only and does not constitute an endorsement by Corning Incorporated of any particular publication, institution, author, product or method.*

- R. Gerardy, M. Winter, A. Vizza, J-C.M. Monbaliu
  Assessing inter- and intramolecular continuous flow strategies towards methylphenidate (Ritalin) hydrochloride
  Reaction Chemistry & Engineering 2, 149-158 (2017)

- K. Lee, H. Lin, K.F. Jensen
  Ozonolysis of quinoline and quinoline derivatives in a Corning low flow reactor
  Reaction Chemistry & Engineering, 2(5), 696-702 (2017)

- S.M. Gaikwad, P.D. Jolhe, B.A. Bhanvase, (...), S.H. Sonawane, S.S. Sonawane
  Process intensification for continuous synthesis of performic acid using Corning Advanced-Flow reactors
  Green Processing and Synthesis, 6 (2), pp. 189-196 (2017)

- Y. Maralla, S. Sonawane, D. Kashinath, M. Pimplapure, B. Paplal
  Process Intensification of Tetrazole reaction through tritylation of 5-[4'-(Methyl) Biphenyl-2-Yl] using microreactors,
  Chemical Engineering & Processing: Process Intensification, 112, pp. 9-17 (2017)

- U. Novak, D. Lavric, P. Žnidaršič-Plazl
  Continuous lipase B-catalyzed isoamyl acetate synthesis in a two-liquid phase system using Corning® AFR™ module coupled with a membrane separator enabling biocatalyst recycle
  Journal of Flow Chemistry, 6 (1), pp. 33-38 (2016)

- M. Peer, N. Weeranoppanant, A. Adamo, Y. Zhang, K.F. Jensen
  Biphasic Catalytic Hydrogen Peroxide Oxidation of Alcohols in Flow: Scale-up and Extraction
  Organic Process Research & Development, 20 (9), pp. 1677-1685 (2016)

- Y. Zhang, S.C. Born, K.F. Jensen
  Scale-up investigation of the continuous phase-transfer-catalyzed hypochlorite oxidation of alcohols and aldehydes
  Organic Process Research and Development, 18 (11), pp. 1476-1481 (2014)

- C. Horn, C. Cerato-Noyerie
  A $PdCl_2$-based hydrogenation catalyst for glass microreactors
  Journal of Flow Chemistry, 4 (3), pp. 110-112 (2014)

- E. Rossi, P. Woehl, M. Maggini
  Scalable in Situ Diazomethane Generation in Continuous-Flow Reactors
  Organic Process Research & Development 16, pp. 1146-1149 (2012)

- J.C.M. Monbaliu, M. Winter, B. Chevalier, F. Schmidt, Y. Jiang, R. Hoogendoorn, M.A. Kousemaker, C.V. Stevens
  Effective production of the biodiesel additive STBE by a continuous flow process
  Bioresource Technology, 102, pp. 9304-9307 (2011)

- J.C.M. Monbaliu, J. Jorda, B. Chevalier, C.V. Stevens, B. Morvan
  Continuous-flow production of alkyl nitrites
  Chemistry Today 29 (3), pp. 50-52 (2011)

- G.S. Calabrese, S. Pissavini
  From batch to continuous flow processing in chemicals manufacturing
  AIChE Journal 57, pp. 828-834 (2011)

- J.C.M. Monbaliu, M. Winter, B. Chevalier, F. Schmidt, Y.I. Jiang, R. Hoogendoorn, M. Kousemaker, C.V. Stevens
  Feasibility study for industrial production of fuel additives from glycerol
  Chemistry Today 28 (4), pp. 8-11 (2010)

- S. Braune, P. Pöchlauer, R. Reintjens, S. Steinhofer, M. Winter, O. Lobet, R. Guidat, P. Woehl, C. Guermeur
  Selective nitration in a microreactor for pharmaceutical production under cGMP conditions
  Chemistry Today 27, pp. 26-29 (2009)

- B. Buisson, S. Donegan, D. Wray, A. Parracho, J. Gamble, P. Caze, J. Jorda, C. Guermeur
  Slurry hydrogenation in a continuous flow reactor for pharmaceutical application
  Chemistry Today 27 (6), pp. 12-16 (2009)

Miscellaneous*

- A. Moniri, H. Wang, X. (Eric) Wu
  Application of corrosion-resistant Corning advanced-flow reactors for multiphase Bunsen reaction
  Part one: Investigation on SO_2 absorption
  International Journal of Petrochemical Science & Engineering 4(4), 122-136, (2019)

- A. Moniri, H. Wang, X. (Eric) Wu
  Application of corrosion-resistant Corning advanced-flow reactors for multiphase Bunsen reaction
  Part two: Investigation on multiphase reaction
  International Journal of Petrochemical Science & Engineering 4(4), 153-160, (2019)

- R. Gérardy, N. Emmanuel, T. Toupy, V. Kassin, N. Ntumba Tshibalonza, M. Schmitz, J.-C. M. Monbaliu
  Continuous Flow Organic Chemistry: Successes and Pitfalls at the Interface with Current Societal Challenges
  European Journal of Organic Chemistry, pp. 2301-2351, (2018)

- D. Lavric, O. Lobet, R. Guidat, A. Vizza, Y. Jiang
  Corning® Advanced-Flow™ Reactors: Innovation Drives Continuous Flow Manufacturing of Chemicals
  Pharma Tech Japan, 33(12), 68-77 (2017)

- H.G. Jolliffe, D.I. Gerogiorgis
  Plantwide design and economic evaluation of two Continuous Pharmaceutical Manufacturing (CPM) cases: Ibuprofen and artemisinin
  Computers and Chemical Engineering 91, 269–288 (2016**)**

- R. Guidat, A. Vizza, Y. Jiang
  Advanced-Flow Reactor Technologies Makes Continuous-Flow Industrial Production Real
  Specialty Chemical Magazine, 35(11), 30-32 (2015)

- O. Bleie, M.F. Roberto, T. I. Dearing, Ch.W. Branham, O.M. Kvalheim, B.J. Marquardt
  Moffat–Swern Oxidation of Alcohols: Translating a Batch Reaction to a Continuous-Flow Reaction
  Journal of Flow Chemistry, 5(3), 183–189 (2015)

**Please note this publication list is provided for reference only and does not constitute an endorsement by Corning Incorporated of any particular publication, institution, author, product or method.*

- M.F. Roberto, T.I. Dearing, S. Martin, B.J. Marquardt
  Integration of Continuous Flow Reactors and Online Raman Spectroscopy for Process Optimization
  J Pharm Innov 7, pp. 69–75 (2012)

- G.A. Marus
  The application of green chemistry and engineering to novel sustainable solvents and processes
  phD Thesis Georgia Institute of Technology (2012)

- F. Schmidt, B.Chevalier
  The future flows through Corning® Advanced-Flow™ glass reactors. Engineered to move you to market faster and more efficiently
  Chemistry Today 27 (2), pp. 4-5 (2009)

- D. Roberge, M. Gottsponer, M. Eyholzer, N. Kockmann
  Industrial design, scale-up and use of microreactors
  Chemistry Today. Vol 27 n4 / July-August (2009)

- L. Ducry, D.M. Roberge
  Dibal-H Reduction of Methyl Butyrate into Butyraldehyde using Microreactors
  Organic Process Research & Development 12, 163-167 (2008)

- P. Barthe, C. Guermeur, O. Lobet, M. Moreno, P. Woehl, D.M. Roberge, N. Bieler, B. Zimmermann,
  Continuous multi-injection reactor for multipurpose production - Part I
  Chemical Engineering and Technology 31, pp. 1146-1154 (2008)

- D.M. Roberge, N. Bieler, M. Mathier, M. Eyholzer, B. Zimmermann, P. Barthe, C. Guermeur, O. Lobet, M. Moreno, P. Woehl
  Development of an industrial multi-injection microreactor for fast and exothermic reactions - Part II
  Chemical Engineering and Technology 31, pp. 1155-1161 (2008)

- B. Chevalier
  Corning microreaction technology, a process intensification solution designed for industrial production
  Chemistry Today 26 (5), pp. 6-7 (2008)

- B. Chevalier, E.D. Lavric, C. Cerato-Noyerie, C.R. Horn, P. Woehl
  Microreactors for industrial multi-phase applications. Test reactions to develop innovative glass microstructure designs
  Chemistry Today, 26 (2), pp. 38-42 (2008)