Next-Gen Manufacturing 2020

Topical Conference at the 2020 AIChE Annual Meeting

Online
16 – 20 November 2020

ISBN: 978-1-7138-2291-2

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571

Some format issues inherent in the e-media version may also appear in this print version.

AIChE
120 Wall Street, FL 23
New York, NY 10005-4020

Phone: (800) 242-4363
Fax: (203) 775-5177

www.aiche.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

(14A) DETECTION OF CYBER-ATTACKS AND RESILIENT OPERATION OF NONLINEAR PROCESSES UNDER ECONOMIC MODEL PREDICTIVE CONTROL 1
Scarlett Chen, Zhe Wu, Panagiotis D. Christofides

(14B) A FRAMEWORK FOR THE IDENTIFICATION AND MITIGATION OF CYBER-ATTACKS IN NETWORKED PROCESS CONTROL SYSTEMS 2
Amr Zedan, Nael H. El-Farra

(14C) RELATING STATE ESTIMATION, DATA-DRIVEN MODELING, AND COMPUTING TO CONTROL SYSTEM CYBERSECURITY 4
Helen Durand, Henrique Oyama

(14D) POST CYBER-ATTACK SECURE STATE RECONSTRUCTION FOR NONLINEAR PROCESSES USING MACHINE LEARNING 5
Zhe Wu, Scarlett Chen, David Rincon, Panagiotis D. Christofides

(46A) DYNAMICAL-SYSTEMS-GUIDED LEARNING OF PDES FROM DATA 6
Hassan Arbabi, Tom S. Bertalan, Anthony Roberts, Giovanni Samaey, Ioannis G. Kevrekidis

(46B) A NEW METHOD FOR BUILDING SURROGATE MODELS OF STOCHASTIC SIMULATIONS 7
Samira Mohammadi, Selen Cremaschi

(46C) MACHINE LEARNING-BASED PREDICTION OF LIQUID WETTABILITY OF ICVD POLYMERS 10
Jacob Hunsberger, Tien Nguyen, Zhengtao Chen, Kenneth Lau, Masoud Soroush

(46D) APPROXIMATING PROCESS SAFETY METRICS USING ARTIFICIAL NEURAL NETWORKS 11
Ahmed Harhara, Akhil Arora, M M Faruque Hasan

(46E) LONG-TERM HYBRID AI-EXPERT COMBUSTION OPTIMIZATION SYSTEM FOR COAL-FIRED ELECTRICITY GENERATION NOX REDUCTION 12
Jacob F. Tuttle, Ricky Vesel, Siva Alagarsamy, Landen Blackburn, Kody M. Powell

(46G) REINFORCEMENT LEARNING AUGMENTED MODEL PREDICTIVE CONTROL WITH FUZZY SUBTRACTIVE CLUSTERING AND FUZZY COGNITIVE MAPPING 13
Elijah Hedrick, Katherine Reynolds, Vinayak Dwivedy, Debangsu Bhattacharyya, Stephen E. Zitney, Benjamin P. Omell

(85A) BATCH-TO-CONTINUOUS TRANSITION IN THE SPECIALTY CHEMICALS INDUSTRY: A CASE STUDY FOR INTENSIFICATION OF DISPERSANTS PRODUCTION 15
Götz Veser, Nasser Al Azri, Riddhesh Patel, Hari C. Mantripragada, Peter Koronaios, Nico Proust, Patrick Newby, Cliff Kowall

(85B) SODIUM TUNGSTATE-PROMOTED PEROVSKITE OXIDES AS EFFECTIVE REDOX CATALYSTS FOR REDOX OXIDATIVE CRACKING OF NAPHTHA 16
Ryan B. Dudek, Fang Hao, Yunfei Gao, Xin Tian, Luke Neal, Fanxing Li

(85C) A DEMONSTRATION OF MEMBRANES FOR THE SEPARATION OF LIGHT OLEFINS AND PARAFFINS 18
Hannah Murnen, Sudip Majumdar, William Charlton, Ken Loprete, Kenneth J. Pennisi, Gerard Rogers

(85D) COMPACT DELIVERY OF UHP HYDROGEN FROM AMMONIA DECOMPOSITION USING CATALYTIC MEMBRANE REACTORS 19
Zhenyu Zhang, Javishk Shah, J. Douglas Way, Colin A. Wolden

(85E) ETHYLENE PRODUCTION USING OXIDATIVE DEHYDROGENATION: EFFECTS OF COMBINED MEMBRANE-BASED & ALTERNATIVE DISTILLATION SEPARATION TECHNOLOGIES ON PROCESS SAFETY & ECONOMICS 20
Anne M. Gaffney, Natalie V. Duprez, Kelsey J. Louthan, Brianna L Borders, James Gasque, Alexander Siegfried, Kenneth L. Roberts, Thomas Stanford, Yousif Alcheikhhamdona, Mina Hoorfar, Bo Chen, Sudip Majumdar, Hannah Murnen

(121A) MICROFLUIDICS-BASED BIOCATALYST-PRODUCT SEPARATION FOR CONTINUOUS ENZYMATIC PROCESSES. A CASE STUDY ON ß-LACTAM ANTIBIOTICS MANUFACTURING 21
Hossein Salami, Sajad Razavi Bazaz, Matthew A. McDonald, Martha A. Grover, Ronald Rousseau, Majid Ebrahimi Warkiani, Andreas Bommarius

(121B) NOVEL INTEGRATION OF CONTINUOUS CRYSTALLIZATION PLATFORMS FOR CONTROL OF CRYSTAL SIZE DISTRIBUTION AND POLYMORPHIC FORM 22
Wei-Lee Wu, Joseph Oliva, Shivani Kshirsagar, Christopher Burcham, Zoltan K. Nagy

(121C) A SCALABLE MEMBRANE PERVAPORATION APPROACH FOR CONTINUOUS FLOW RING CLOSING METATHESIS 24
Matthew Bio, Hannah Murnen, Ning Shangguan, Sudip Majumdar, Christopher P. Breen, Christine Parrish, Timothy Jamison

(121D) DEVELOPMENT OF CONTINUOUS HOMOGENEOUS HYDROGENATION PROCESS FOR PHARMACEUTICALS USING A FLOW REACTOR 25
Onkar Manjrekar, Duygu Gerceker, Greg Storer, Brian Kotecki, Kaid Harper, Elie Chaaya, Shashank Shekhar, Moiz Diwan

(121E) LIQUID PHASE PEPTIDE SYNTHESIS VIA NANOSTAR-SIEVING 26
Jet Yeo, Ludmila G. Peeva, Piers Gaffney, Carla Luciani, Fernando Albericio, Andrew G. Livingston

(121F) LIQUID-LIQUID EXTRACTIONS IN API MANUFACTURING PROCESSES: IS CONTINUOUS THE WAY TO GO? 28
Rui Pina Campos, Maria Inês Lopes, Ruth Morais, Susana Nascimento

(121G) DEVELOPMENT AND PROCESS INTENSIFICATION OF A THREE STEP CONTINUOUS FLOW PROCESS FOR TELESCOPED HIGH ENERGY REACTIONS 29
Christopher Lippelt, Pieter Otten, Shawn Conway

(144A) PRODUCING PREDICTIVE CHEMICAL PROCESS MODELS FROM A STATE OF INCOMPLETE MECHANISTIC KNOWLEDGE AND SMALL DATA SETS 30
Daniel Griffin, Seth Huggins

(144C) IDENTIFYING THE PROCESSING SPACE OF CONTINUOUS GRANULATION: A CASE STUDY OF EXTENDED RELEASE TABLETS 31
Ahmed Zidan

(144D) DYNAMIC OPTIMIZATION STRATEGIES TOWARDS ADDRESSING THE CHALLENGES IN PROTEIN THERAPEUTICS 33
Chrysoula D. Kappatou, Adel Mhamdi, Alexander Mitsos

(144E) INTEGRATED SUPPLY CHAIN NETWORK DESIGN AND INVENTORY MANAGEMENT FOR AUTOLOGOUS CELL THERAPY. 35
Apoorva Katragadda, Iftekhar A. Karimi, Xiaonan Wang

(144F) TWO-STAGE CONTROL USING MODEL-BASED REINFORCEMENT LEARNING AND PREDICTIVE CONTROL FOR FED-BATCH BIOREACTOR 36
Tae Hoon Oh, Jong Min Lee

(144G) SUSTAINABLE API DEVELOPMENT: DEVELOPING A STRATEGY FOR MEASURING AND REDUCING ENVIRONMENTAL IMPACT IN THE PHARMACEUTICAL INDUSTRY 38
David Streather, Anna Parsons

(156B) AN INTEGRATED PROCESS AUTOMATION SYSTEM IN API MANUFACTURING: KEY CHARACTERISTICS AND CASE STUDY 39
Da Pan

(156E) A QUANTITATIVE ASSAY OF SODIUM TRIACETOXYBOROHYDRIDE 40
Michael Zacuto, Joseph Perona, Robert Dunn

(156F) DELIVERY STRATEGIES FOR LIVE THERAPEUTIC BACTERIA 41
Ava M. Vargason, Ryann Callaghan, Shruti Santhosh, Aaron C. Anselmo

(156G) IN VITRO BIOMIMETIC TUMOR MODEL WITH CANCER-SPECIFIC GENE REGULATORS AND GREEN FLUORESCENCE REPORTER FOR HIGH THROUGHPUT DRUG SCREENING 42
Shang-Tian Yang, You Li

(156I) PREPARATION AND USE OF FINE GRADE ENGINEERED EXCIPIENTS FOR DIRECT COMPRESSION OF BINARY BLENDS OF COHESIVE DRUG POWDERS 43
Zhixing Lin, Liang Chen, Kai Zheng, Kuriakose Kunnath, Sangah Kim, Rajesh Davé

(156J) APPLYING MACHINE LEARNING TO PREDICT THERAPEUTIC ANTIBODY VISCOSITY 44
Pin-Kuang Lai

(156K) DEVELOPMENT OF MULTI-ADJUVANT SYSTEMS FOR VACCINES AGAINST INFECTIOUS DISEASES 45
Julia E. Vela Ramirez, Lauren A. Austin, Heidi Ferguson, Pedro J. Cejas, Rob Saklatvala

(156L) DEVELOPMENT OF A HARVEST SMALL SCALE MODEL TO SIMULATE CONTINUOUS CENTRIFUGATION 46
Jianfa Ou, Qing Wong, Michael Kagan, Dominique Monteil, Daniel Bock

(156M) OPTIMIZING AND REDUCING CLEANING PRODUCTION LOSS IN PHARMA, AGROCHEMICAL AND SPECIALTY CHEMICAL COMPANIES USING A NEW EXPERT SYSTEM. 47
Joan Cordiner

(156N) REVOLUTIONIZE OF PHARMACEUTICAL PRODUCT CHANGEOVERS BY ENHANCED CLEANING WITH MICROBUBBLES 48
William B. Zimmerman, Joan Cordiner

(14E) KEYNOTE: CYBERSECURITY FOR CRITICAL INFRASTRUCTURE SYSTEMS 49
Nathaniel Gleason, Chloe Applegate, Jovana Helms

(14F) KEYNOTE: INTEGRATING CYBERSECURITY INTO PHA AND PSM 50
Addie Cormier, Christopher Ng

(108A) MACHINE LEARNING APPROACH FOR TOOL CONDITION MONITORING IN MANUFACTURING SYSTEMS 51
Seulki Han, Tom Maloney, George M. Bollas

(108B) FAST-CONVERGENCE OF DEEP REINFORCEMENT LEARNING CONTROLLER: APPLICATION TO A CONTINUOUS STIRRED TANK REACTOR 54
Mohammed Saad Faizan Bangi, Joseph Kwon

(108C) SMART PROXY MODELING FOR CFD; APPLICATION OF ARTIFICIAL INTELLIGENCE & MACHINE LEARNING TO NUMERICAL SIMULATION 55
Shahab D. Mohaghegh, Mehrdad Shahnam, Ayodeji Aboaba, Yvon Martinez, Chris Guenther, Yong Liu

(108D) COMPARISON OF STATE-OF-THE-ART DYNAMIC MACHINE LEARNING METHODS FOR MPC OF COAL-FIRED UTILITY GENERATOR PERFORMANCE 56
Jacob F. Tuttle, Landen Blackburn, Kody M. Powell

(108E) INTEGRATING MACHINE-LEARNING METHODS FOR ADAPTIVE MODEL PREDICTIVE CONTROL DESIGN 58
Hesam Hassanpour, Brandon Corbett, Prashant Mhaskar

(108F) AN EFFICIENT REINFORCEMENT ALGORITHM APPROACH TO OPTIMAL CONTROL AND ENVIRONMENTAL SUSTAINABILITY 60
Shiam Kannan, Urmila Diwekar

(147B) PERFORMANCE OF SWEEPING GAS MEMBRANE DISTILLATION FOR TREATING PRODUCED WATER: MODELING AND EXPERIMENTS 61
Amit Thakur, I-Min Hsieh, M. R. Islam, Bosong Lin, Mahdi Malmali

(147C) GENERALIZED MODULAR/COLLOCATION FRAMEWORK FOR REPRESENTATION AND SYNTHESIS OF INTENSIFIED MULTI-SCALE REACTION SYSTEMS 62
Yuhe Tian, Dionisios G. Vlachos, Efstratios N. Pistikopoulos

(147D) DYNAMIC DATA RECONCILIATION, PARAMETER ESTIMATION, AND PLANT-WIDE MODELING OF A MICROWAVE (MW)-ASSISTED DIRECT NON-OXIDATIVE METHANE DEHYDROAROMATIZATION (DHA) PROCESS 64
Chirag Mevawala, Xinwei Bai, Jianli Hu, Victor Abdelsayed, Dushyant Shekhawat, Debangsu Bhattacharyya

(147E) MULTIPHASE MICROCHANNEL SEPARATOR: A MICROFLUIDIC PLATFORM FOR THE INTENSIFICATION AND MODULARIZATION OF SOLUTE EXTRACTION AND PHASE SEPARATION 65
Jad Touma, Matthew Coblyn, Lucas Freiberg, Goran Jovanovic

(224A) DATA-EFFICIENT PROBABILISTIC MODEL LEARNING WITH EMBEDDED HIGH-FIDELITY KNOWLEDGE FOR BIOMANUFACTURING IN DEEP SPACE MANNED MISSIONS 67
Georgios Makrygiorgos, Aaron Berliner, Adam P. Arkin, Ali Mesbah

(224B) RECOGNIZING AND AVOIDING BIG DATA ANALYTICS TRAPS IN APPLICATIONS 68
Weike Sun, Richard Braatz

(224C) DATA-DRIVEN AND HYBRID MODELING OF INTEGRATED PAPER PRODUCTION SYSTEMS 69
Jinhyeun Kim, Kamran Paynabar, Christopher O. Luettgen, Fani Boukouvala

(224D) OPTIMAL OPERATION OF PLASMA ENHANCED ATOMIC LAYER DEPOSITION VIA MACHINE LEARNING 70
Yangyao Ding, Yichi Zhang, Panagiotis D. Christofides

(224E) SYSTEM VISUALIZATION USING REAL-TIME DATA-DRIVEN MODELS DERIVED FROM HIGH-RESOLUTION SENSOR PROFILING 71
Chenyu Wang, Tianbao Wang, Baikun Li, Matthew D. Stuber

(224F) TOWARDS THE USE OF MULTI-RELATIONAL DATA MINING (MRDM) IN BIOPROCESS MODELS 74
Simoneta Caño De Las Heras, Carina Gargalo, Isuru A. Udugama, Krist V. Gernaey, Ulrich Krühne

(224G) THE ALGORITHM TO DISCRIMINATE FACTORS OF DEFECTS AND DETERMINE THE COUNTERMEASURES FROM PROCESS DATA AND APPLICATION TO HIGHLY-FUNCTIONAL FILM PROCESS 76
Daisuke Yagi, Hidenori Takai, Hiroki Watanabe

(353A) MAINTENANCE TESTING IN PRECISION MACHINING 77
Utsav Awasthi, Tom Maloney, George M. Bollas

(353B) CONVOLUTIONAL NEURAL NETWORK FOR PREDICTING MORPHOLOGY, FLOW AND TRANSPORT PROPERTIES OF COMPLEX MATERIALS 79
Serveh Kamrava, Muhammad Sahimi, Pejman Tahmasebi

(353C) DEVELOPING A CLOSED-LOOP OPTIMUM PUMPING SEQUENCE WITH SHEAR THINNING FLUID FOR ENHANCED HYDRAULIC FRACTURING 80
Silabrata Pahari, Mustafa Akbulut, Joseph Kwon

(353D) DEVELOPING A HYBRID MODEL OF A BIOCHEMICAL FERMENTATION PROCESS 82
Parth Shah, Dongheon Lee, Joseph Kwon

(353E) A COMBINED COMPUTATIONAL-FLUID-DYNAMICS MODEL AND ADVANCED CONTROL STRATEGIES FOR DIRECT PERFUSION BIOREACTOR SYSTEMS 84
Ioana Nascu, Daniel Sebastia-Saez, Tao Chen, Wenli Du

(353F) MODELING A DIRECT- FIRED INDUSTRIAL TUNNEL FURNACE USING AN IMPLICIT MULTIPLE 1D APPROACH 86
Andreas Rath, Christoph Spijker, Harald Raupenstrauch

(353G) PARTICLE-RESOLVED PACKED BED REACTOR SIMULATION: ADVANCES IN CONTACT POINT TREATMENT 87
Thomas Eppinger, Gregor D, Wehinger

(366A) CONTINUOUS MIXING TECHNOLOGY: THE IMPACT OF BLEND PROPERTIES AND PROCESS PARAMETERS ON MIXING PERFORMANCE 88
Kai Lee, James Kimber, Pankaj Doshi, Jenna Brandon, David Wilsdon, Daniel O. Blackwood, Ashwinkumar Jain

(366B) INVESTIGATION OF CRITICAL PROCESS PARAMETERS OF SCREW ELEMENTS OF A TWIN SCREW EXTRUDER BY AN IMPROVED SIMULATION METHOD 89
Vanessa Duephans, Isabella Putz, Julius Arntzen, Markus Thommes

(366C) DRUG PRODUCT CONTINUOUS POWDER FEEDING FOR LOW-PERCENTAGE FORMULATION COMPONENTS 93
Carl Hartmann III, Jon Hilden

(366D) STOCHASTIC ANALYSIS AND MODELING OF PHARMACEUTICAL SCREW FEEDER MASS FLOW RATES 94
Brad Johnson, Salvador García-Muñoz, Maitraye Sen, Joshua Hanson, David Slade, Nick Sahinidis

(366E) TABLET PAN COATING PERFORMANCE DURING SCALE UP AND BETWEEN BATCH AND CONTINUOUS PROCESSES 95
Michael Choi, Stuart C. Porter, Betsy Macht

(366F) DESIGN METHOD FOR INJECTABLE MANUFACTURING PROCESSES CONSIDERING CONTINUOUS AND BATCH COMPOUNDING 99
Masahiro Yamada, Yasuyuki Yoshioka, Hayao Nakanishi, Hirokazu Sugiyama

(366G) EFFICIENT PRODUCTION OF MULTI-COMPONENT AMORPHOUS SOLID DISPERSIONS BY SPRAY DRYING 100
Vojtech Klimsa, Gabriela Ruphuy Chan, František Štepánek

(662A) METAL-OXIDE NANOARRAY BASED CATALYSTS FOR WATER ELECTROLYSIS AND CO2 CONVERSION AT HIGH EFFICIENCY AND LOW COST 102
Pu-Xian Gao

(662B) MICROWAVE CATALYTIC REACTOR FOR PROCESS INTENSIFIED CONVERSION OF STRANDED ENERGY RESOURCES 103
Jianli Hu

(662C) MULTI-SCALE SYSTEMS ANALYTICS FOR SUSTAINABLE PROCESS ENGINEERING 104
Fengqi You

(662D) COMPOSITE IONIC LIQUID ALKYLATION(CILA) PROCESS PRODUCES HIGH-QUALITY GASOLINE 105
Chunming Xu

(205A) PROCESS DESIGN AND INTENSIFICATION OF DIVIDING WALL COLUMN FOR AN INDUSTRIAL METHYL METHACRYLATE SEPARATION PROCESS 106
Yuhe Tian, Vaishnav Meduri, Shivam Vedant, Rahul Bindlish, Efstratios N. Pistikopoulos

(205B) THERMAL ANALYSIS OF STRUCTURED REACTORS FOR MICROWAVE REACTION ENGINEERING 108
Abhinav Malhotra, Weiqi Chen, Ignacio Julian, Jose M. Catala-Civera, Dionisios G. Vlachos, Dionisios G. Vlachos

(205C) COST-EFFECTIVE TECHNOLOGY IDENTIFICATION & UNCERTAINTY QUANTIFICATION OF STRANDED SOUR GAS DESULFURIZATION PROCESSES 109
Chinmoy Basak M., Shuang Xu, Yushi Deng, Selen Cremaschi, Mario Eden, Bruce Tatarchuk, Bruce Tatarchuk, Kylie Webb, Harrison Wright, Paul S. Dimick

(205D) PROCESS INTENSIFICATION INSIGHTS THROUGH COMPUTATIONAL CATALYSIS STUDIES: SELECTIVE ETHYLENE OXIDE FORMATION ON AG CATALYSTS 110
Siyuan Wu, Bruce J. Tatarchuk, Andrew Adamczyk

(205E) SIMULATION OF PRESSURE SWING ADSORBERS USING THE MOVING BED MODEL 111
Michael Sees, Toni Kirkes, Taehun Kim, Joe Scott, Chau-Chyun Chen

(287A) DYNAMIC DATA RECONCILIATION, PARAMETER ESTIMATION, AND VALIDATION FOR THE DYNAMIC MODEL OF A SUPERCRITICAL PULVERIZED COAL POWER PLANT 112
Vinayak Dwivedy, Elijah Hedrick, Katherine Reynolds, Debangsu Bhattacharyya, Stephen E. Zitney, Benjamin P. Omell

(287B) FORECASTING PRICES OF ENERGY FEEDSTOCKS AND COMMODITIES USING ADVANCED STATISTICAL AND MACHINE LEARNING METHODS 114
Stefanos G. Baratsas, Detlef R. Hallermann, Sorin M. Sorescu, Efstratios N. Pistikopoulos

(287C) IMPLEMENTATION OF HYBRID MODELS TO PERFORM SYSTEM ANALYSES WITH MODEL MAINTENANCE IN CONTINUOUS PHARMACEUTICAL MANUFACTURING 116
Yingjie Chen, Marianthi Ierapetritou

(287D) UTILIZATION OF ADVANCED ANALYTICS TO MONITOR CATALYST HEALTH IN AN ETHYLENE OXIDE REACTOR 119
Sahin Sarrafi, Hasan Sildir, Yasar S. Kabak

(287E) COLLABORATION IS CRITICAL FOR EFFECTIVE DEPLOYMENT OF BIG DATA ANALYTICS 120
Joseph Reckamp

(287F) DYNAMIC DATA FEATURE ENGINEERING FOR PROCESS OPERATION TROUBLESHOOTING 121
S. Joe Qin, Yingxiang Liu, Yining Dong

(395A) (INVITED TALK) COUNTING MOLECULES, DODGING BLOOD CELLS: CONTINUOUS, REAL-TIME MOLECULAR MEASUREMENTS DIRECTLY IN THE LIVING BODY 123
Kevin Plaxco

(395B) ULTRASENSITIVE, SELECTIVE, AND REVERSIBLE ROOM-TEMPERATURE NO2 SENSOR BASED ON A MONOLAYER TRANSITION METAL DICHALCOGENIDE 124
Amin Azizi, Mehmet Dogan, Hu Long, Jeffrey Cain, Kyunghoon Lee, Rahmatollah Eskandari, Alessandro Varieschi, Emily Glazer, Marvin L. Cohen, Alex Zettl

(395C) ATOMICALLY-THIN SENSING SURFACES FROM 2D MATERIALS FOR DETECTING CELLULAR GAPS 125
Volodymyr Koman, Xun Gong, Naveed Bakh, Michael Strano

(395E) NANOCOMPOSITES OF MULTIWALLED CARBON NANOTUBES AND PALLADIUM-BASED NANOSHEETS FOR HYDROGEN SENSING 126
Abhishek Kumar, Mohammad Moein Mohammadi, Jun Liu, Thomas Thundat, Mark T. Swihart

(395F) FLAME AEROSOL SYNTHESIS OF PALLADIUM-DECORATED CRUMPLED REDUCED GRAPHENE OXIDE NANOCOMPOSITES FOR HYDROGEN DETECTION AT ROOM TEMPERATURE 127
Mohammad Moein Mohammadi, Abhishek Kumar, Jun Liu, Yang Liu, Thomas Thundat, Mark T. Swihart

(395H) CARBON BLACK-GOLD NANOPARTICLES FOR DETECTION OF ANALYTES USING SURFACE ENHANCED RAMAN SCATTERING 128
Akram Abbasi, Tania Oliveira, Geoffrey D. Bothun, Arijit Bose

(396A) 3D PRINTING FOR HIGH PERFORMANCE POLYMERS AND NANOCOMPOSITES 129
Rigoberto Advincula

(396B) ROOM-TEMPERATURE 3D PRINTING OF A SUPER-SOFT AND SOLVENT-FREE ELASTOMER 130
Renxuan Xie, Sanjoy Mukherjee, Christopher M. Bates, Michael L. Chabinyc

(396C) HIGH TG, LOW VISCOSITY RESIN SYSTEMS BASED ON ISOSORBIDE METHACRYLATE (IM) FOR ADDITIVE MANUFACTURING 131
Xi Chu, John La Scala, Giuseppe Palmese

(396D) INVESTIGATION OF THE PHYSIOCHEMICAL EFFECTS OF HEAT-INDUCED AGING ON 3D PRINTED PHOTOPOLYMERS 132
Whytneigh R. Duffie, Sung-Hwan Yoon, Charlie Chen, Travis W. Walker

(396E) CONTINUUM SIMULATIONS OF POLYMER DEPOSITION IN FUSED-FILAMENT FABRICATION (FFF) 133
Benjamin E. Dolata, Peter D. Olmsted

(396G) SYSTEMATIC APPLICATION OF 3D BIOPRINTING IN THE FABRICATION OF A COMPOSITE FULL THICKNESS HUMAN SKIN MODEL 134
Jia Heng Teoh, Anbu Mozhi Thamizhchelvan, Wang Chi-Hwa

(399A) CONSTRAINED CONTROL OF DISSIPATIVE DISTRIBUTED PARAMETER SYSTEMS VIA ON-DEMAND DATA-DRIVEN MODEL REDUCTION 135
Davood Babaei Pourkargar, Antonios Armaou

(399B) DESIGN OF OPTIMAL MULTI-SIZE PROPPANT PUMPING SCHEDULE TO ENHANCE SHALE GAS PRODUCTION 137
Parth Bhandakkar, Prashanth Siddhamshetty, Joseph Kwon

(399C) MOLECULES TO SYSTEMS DESIGN OF ADVANCED MEMBRANE MATERIALS AND TECHNOLOGIES 138
Elvis Eugene, Xinhong Liu, William A. Phillip, Alexander Dowling

(399D) DEVELOPMENT OF CONDITION MONITORING AND PROGNOSTIC CAPABILITIES FOR A VANADIUM REDOX FLOW BATTERY 140
Sai Pushpitha Vudata, Debangsu Bhattacharyya, Richard Turton

(399E) DATA-DRIVEN OPTIMIZATION OF MANUFACTURING SYSTEMS UNDER SUPPLY AND DEMAND VOLATILITIES IN AN INDUSTRIAL SYMBIOSIS NETWORK 141
Manu Suvarna, Pravin P S, Xiaonan Wang

(399F) COMPREHENSIVE DYNAMIC SIMULATION MODEL OF A CRYOGENIC STORAGE TANK 142
Aruna Coimbatore Meenakshi Sundaram, Iftekhar A. Karimi

(399G) ONTOLOGY ENGINEERING: SUPPORT TO DECISION MAKING IN BIOREFINING 144
Linsey Koo, Edlira Kalemi, Nikolaos Trokanas, Franjo Cecelja

(413B) HYDROTHERMAL LIQUEFACTION OF UNHYDROLYZED SOLIDS FOR FUELS AND VALUE-ADDED PRODUCTS 146
Vinod S. Amar, Bharath Maddipudi, Anuradha Shende, Joseph Houck, Sergio Hernandez, Katelyn Shell, Dylan Rodene, Anuj Thakkar, Runzhou Huang, Hao Fong, Sandeep Kumar, Ram B. Gupta, Rajesh Shende

(413D) UNDERSTANDING OF METABOLIC PATHWAYS IN PSEUDOMONAS PUTIDA FOR BIOSYNTHESIS OF PHA USING SUGAR, GLYCEROL, BENZOATE, AND THEIR COMBINATIONS 147
Zhangyang Xu, Xiaolu Li, John R Cort, Wei-Jun Qian, Bin Yang

(413F) LIGNIN-BASED DROP-IN JET FUEL PRODUCTION 148
Bin Yang

(413G) TOWARD FEEDSTOCK DESIGN FOR BIOMATERIAL: NOVEL BIOMASS STRUCTURE CHARACTERISTICS DETERMINING PROPERTIES OF LIGNIN-BASED CARBON FIBER 149
Joshua Yuan

(452A) 3D-PRINTED ZEOLITE MONOLITHS WITH METAL DOPANTS FOR METHANOL CONVERSION 150
Fatima Magzoub, Shane Lawson, Fateme Rezaei, Ali Rownaghi

(452D) FLUID FLOW CONTROL DEVICES WITH 3D-GRADED PERMEABILITY 151
David B. Robinson, Maher Salloum, Denis Ridzal, Drew P. Kouri, David J. Saiz, Bradley H. Jared

(452E) 3D PRINTED GYROID-LIKE STRUCTURED PACKINGS 152
Du Nguyen, Nathan C. Ellebracht, Pratanu Roy, Jaisree K. Iyer, Julie A. Mancini, William L. Smith, Simon H. Pang, Joshuah K. Stolaroff

(452G) COUPLED NUMERICAL AND EXPERIMENTAL ANALYSIS OF TRANSPORT PROPERTIES IN 3D-PRINTED PERIODIC CELLULAR MEDIA TO ENABLE CATALYTIC REACTORS DESIGN 153
Claudio Ferroni, Federico S. Franchi, Matteo Ambrosetti, Mauro Bracconi, Riccardo Balzarotti, Matteo Maestri, Gianpiero Groppi, Enrico Tronconi

(452H) DEVELOPMENT OF POLYMER MONOLITH PD CATALYSTS FOR BATCH, MODULAR CONTINUOUS FLOW AND NOVEL 3-D PRINTED PEEK REACTOR PLATFORMS FOR HYDROGENATION REACTIONS 156
Matthew Edwards, Matthew Harding, Roderick Jones, Brian Glennon, Marcus Baumann, Steven Ferguson

(459A) MOLECULAR RECOGNITION AND IN VIVO DETECTION OF TEMOZOLOMIDE AND 5-AMINOIMIDAZOLE-4-CARBOXAMIDE FOR GLIOBLASTOMA USING FLUORESCENT NANOSENSORS 157
Manki Son, Freddy T. Nguyen, Punit Mehra, Michael A. Lee, Naveed Bakh, Michael Strano

(459B) AN ENZYMATIC ELECTROCHEMICAL BIOSENSOR FOR REAL-TIME DETECTION OF PHYSIOLOGICALLY RELEVANT NICOTINE CONCENTRATIONS 158
Uros Kuzmanovic, Mingfu Chen, Margarita Tararina, Nicolas S. Shu, Prerana Sensharma, Anant Gupta, Andy Fan, Catherine M. Klapperich, Karen Allen, Mark Grinstaff, James Galagan

(459C) SIMULATIONS GUIDE OPTIMIZATION OF ELECTROENZYMATIC BIOSENSORS FOR NEUROTRANSMITTERS AND ENABLE PROPER INTERPRETATION OF SENSOR RESPONSE IN VIVO 159
Mackenzie Clay, Harold G. Monbouquette

(459D) THEORETICAL AND EXPERIMENTAL STUDIES ON AN ELECTROCHEMICAL ENZYME IMMUNOSORBENT BIOSENSOR 160
Neda Rafat, Paul Satoh, Robert M. Worden

(459E) HTL DERIVED BIOCHAR AND GRAPHENE NANOPLATELETS FOR BIOSENSOR APPLICATIONS 161
Bharath Maddipudi, Vinod S. Amar, Hope Dosch, Anuradha Shende, Rajesh Shende

(459F) CONSTRUCTION OF A RED EMISSION BODIPY-BASED PROBE FOR TRACING LYSOSOMALVISCOSITY CHANGES IN CULTURE CELLS 162
Baoxing Shen

(459G) SUPER SENSITIVE CERIUM OXIDE-BASED COMPOSITE SENSOR FOR THE DETECTION OF HYDROXYL RADICALS 163
Surachet Duanghathaipornsuk, Cheng-Han Li, Joerg Jinschek, Dong-Shik Kim, Ana Alba-Rubio

(459H) HIGH THROUGHPUT ANTIBIOTIC SUSCEPTIBILITY TESTING WITH OPTICAL NANOSENSORS 164
Megan Jewell, Samuel C. Saccomano, Alexa A. David, J. Kirk Harris, Edith Zemanick, Kevin J. Cash

(481A) RENEWABLE NH3 AS ALTERNATIVE ENERGY FUEL FOR OCEAN EXPLORATION 165
Jian Liu, Yuyan Shao, Vassiliki-Alexandra Glezakou, Robert Cavagnaro, Li-Jung Kuo

(481B) MIXED-PHASE PEROVSKITE MATERIALS FOR H2 GENERATION AND HYBRID CHARGE STORAGE 166
Joseph Houck, Vinod S. Amar, Bharath Maddipudi, Anuradha Shende, Rajesh Shende

(481C) HYDROGEN AND AMMONIA FOR RENEWABLE ENERGY STORAGE: THE ECONOMICS OF LOCATION, SCALE, AND DEMAND TYPE 167
Matthew Palys, Prodromos Daoutidis

(481D) HYDROTHERMAL LIQUEFACTION OF BAGASSE FOR H2, BIO-OIL AND HIGH VALUE PRODUCTS 169
Vinod S. Amar, Anuradha Shende, Bharath Maddipudi, Rajesh Shende

(481E) CUO-CU2O REDOX THERMOCHEMICAL STORAGE FOR HIGH-TEMPERATURE SOLAR PROCESS HEAT 170
Marco Gigantino, Sebastian Sas Brunser, Aldo Steinfeld

(486A) RESPONSIBLE INNOVATION IN CHEMICAL PROCESS DESIGN: STAKEHOLDER-DRIVEN MULTI-OBJECTIVE OPTIMIZATION OF A MODULAR FOOD WASTE VALORIZATION PROCESS 171
Michael Abramovitch, Marianthi Ierapetritou

(486E) SOLVENT OPTIMIZATION IN REACTIVE EXTRACTION FOR PROCESS INTENSIFICATION IN BIOMASS UPGRADE 173
Souryadeep Bhattacharyya, Zhaoxing Wang, Dionisios G. Vlachos

(486F) PROCESS SYNTHESIS AND INTENSIFICATION FOR UPGRADING NATURAL GAS LIQUIDS IN SHALE GAS 174
Zewei Chen, Yiru Li, Edwin Andres Rodriguez Gil, Rakesh Agrawal

(486G) PILOT-SCALE DEMONSTRATION OF COAL WASTE AND TORREFIED MUNICIPAL SOLID MIXTURES WITH AN ENTRAINED FLOW GASIFIER 175
Nicholas R. Schwartz, Michael J. Blaise

(500A) MACHINE LEARNING REACTIVITY IN NETWORKS OF COUPLED GAS PHASE REACTIONS 176
Stephanie Valleau

(500C) PROGRESS IN APPLYING AI/ML TO REACTION ENGINEERING AND CHEMICAL SYNTHESIS 177
Connor W. Coley

(519A) AN ADDITIVE MANUFACTURING PROCESS FOR PRODUCING INTEGRATED OPTOELECTRONIC FLEXIBLE ELECTRONICS 178
Roger B. Tipton, Dianhao Hou, Thomas M. Weller, Venkat Bhethanabotla

(519B) LIGHTWEIGHT POLYMER LATTICES WITH UNCONVENTIONAL MECHANICAL PROPERTIES 179
Tark Giri, Russell Mailen

(519D) NUMERICAL SIMULATION OF THE EXTRUSION PROCESS IN FUSED DEPOSITION MODELING: THE EFFECTS OF PROCESS VARIABLES ON THE PRESSURE DROP IN THE NOZZLE 180
Behrouz Behdani, Joontaek Park

(519E) QUANTITATIVE ANALYSIS OF HYDROGEL-BASED CEMENT PASTES FOR 3D PRINTING APPLICATIONS 181
Hajar Taheri Afarani, Venkat Padmanabhan, William R. Carroll, Joseph J. Biernacki

(519F) 3D PRINTING OF SIC ROCKET NOZZLES USING VIBRATION ASSISTED PRINTING 182
Emre Gunduz

(523A) SURPASSING THE DETECTION LIMIT AND ACCURACY OF ELECTROCHEMICAL DNA SENSOR THROUGH THE APPLICATION OF CRISPR-CAS SYSTEMS 183
Yifan Dai, Wei Xu, Chung-Chiun Liu

(523B) IN PLANTA DETECTION OF SYNTHETIC AUXIN PLANT HORMONES USING SINGLE-WALLED CARBON NANOTUBES (SWNT) BASED NANO-SENSORS 184
Mervin C. Ang, Niha Dhar, Duc T. Khong, Tedrick Thomas Salim Lew, Minkyung Park, Rajani Sarojam, Mary B. Chan-Park, Michael Strano

(523C) ELECTROCHEMICAL SENSORS FOR MICROBIAL ACTIVITIES IN BENTHIC SEDIMENTS: A SENTRY FOR LACUSTRINE P BIOGEOCHEMISTRY 185
Alex Simler, Joshua Davis, John Senko, Chelsea Monty

(523D) IOT BASED FUEL ADULTERATION DETECTION USING DISPERSION MODEL AND TAIL PIPE EMISSIONS 186
Shubham Sharma, Hemant Langar, Mohit Kumar

(523F) IN-SITU CHEMICAL COMPOSITION SENSING USING IR ADSORPTION IN MICRO-STRUCTURED FLOW REACTORS 187
Bradley P. Ladewig, Jun Li, Roland Dittmeyer

(523G) RAPID DETECTION OF TUBERCULOSIS BREATH BIOMARKERS USING ENGINEERED ELECTROACTIVE SOLUTIONS (EAS) 188
Christina Willis, Shaylee Larson, Alfred Andama, Devan Jaganath, Adithya Cattamanchi, Manoranjan Misra, Swomitra Mohanty

(537A) DEPOSITION OF OXIDE COATINGS USING NON-THERMAL ATMOSPHERIC PRESSURE PLASMAS 190
David Barlaz, Dhruval Patel, Zachary Jeckell, Daniel Krogstad, Brian Jurczyk, David Ruzic

(537B) TREATMENT AND EXTRACTION OF COPPER FROM ELECTRONIC WASTE VIA INDUCED MORPHOLOGICAL CHANGES UTILIZING SUPERCRITICAL CO2 191
Emily Hsu, Christopher Durning, Alan West, Ah-Hyung Alissa Park

(537C) ANNEALING CARBON BY PULSED LASER LIGHT 192
Randy Vander Wal, Akshay Gharpure

(537D) AN ALL-IN-ONE APPROACH FOR TRAINING DEEP LEARNING-BASED CONTROL LAWS 194
Yankai Cao

(537E) CLOUD-BASED CONTROL OF A ROBOTIC MANUFACTURING PROCESS FOR PERSONALIZED MEDICINES 197
Alice Melocchi, Zack Bright, Federico Parietti

(537G) EMERGING COGNITIVE ENGINEERING APPROACHES TO ENHANCE CONTROL ROOM OPERATOR CAPABILITIES IN CHEMICAL INDUSTRIES 199
Mahindra Choudhary, Md. Umair Iqbal, Babji Srinivasan, Rajagopalan Srinivasan

(544A) THE FLORY-HUGGINS PARAMETERS OF BINARY IONIC LIQUID MIXTURES WITH AMMONIA 202
Tugba Turnaoglu, Mark B. Shiflett

(544B) PREDICTING HYDROGEN BOND DONATING ABILITY BETWEEN NITROANILINE DYES AND TYPE III DES USING TZVP BASED COSMO MODELS 203
Kyle McGaughy, Thomas Quaid, Toufiq Reza

(544C) THERMALLY STABLE IONIC LIQUID AS MEDIA FOR SEPARATING ALIPHATIC AND AROMATIC COMPOUNDS 204
Santosh Rathan Paul Bandlamudi, Jimmie McGehee, Albaraa D. Mando, James H. Davis Jr., Kevin N. West, Brooks Rabideau

(544D) EFFECTS OF PHYSICAL STRUCTURE OF ALKYLAMMONIUM HYDROGEN SULFATE IONIC LIQUIDS ON ACIDITY 205
Anton E. J. Firth, Sochi Amako, Paul Fennell, Jason P. Hallett

(544E) HIGHLY SELECTIVE ELECTROCHEMICAL REDUCTION OF CO2 TO CO VIA A NOVEL CATALYST WITH MN-N3 SITE 207
Jiaqi Feng, Shaojuan Zeng, Suojiang Zhang, Xiangping Zhang

(544F) THERMODYNAMIC STUDIES/ANALYSIS OF NH3 ABSORPTION IN PYRIDINIUM-BASED PROTIC IONIC LIQUIDS 208
Lei Yuan

(544G) AQUEOUS IONIC AMINES FOR CO2 CAPTURE IN AIR REVITALIZATION 209
Kevin N. West, Ziyad Mando, Randi Swanson, T. Grant Glover, James H. Davis Jr., W. Matthew Reichert

(544H) SEPARATION OF HYDROFLUOROCARBON MIXTURES USING IONIC LIQUIDS 211
Kalin R. Baca, Greta M. Olsen, Lucia Matamoros Valenciano, Abby N. Harders, Andrew D. Yancey, Ethan Finberg, Mark B. Shiflett

(544J) FUNCTIONALIZED IONIC LIQUIDS BASED ON VEGETABLE OILS FOR RARE EARTH ELEMENTS RECOVERY 212
Fujian Li, Xiangping Zhang, Yinge Bai, Shaojuan Zeng, Suojiang Zhang

SPONSORED TECHNOLOGY WORKSHOP - DIGITAL TRANSFORMATION FOR A SUSTAINABLE FUTURE - AVEVA 213
Julien De Beer, Ian Willetts, Mihaela Hahne

(268B) SCALABLE MODULAR MANUFACTURING OF AMINO ACID CRYSTALS WITH IMPROVED UNIFORMITY 214
Mo Jiang

(268C) ON DEMAND TREATMENT OF WASTEWATER USING 3D-PRINTED MEMBRANES 215
Bingchen Wang, Yihan Song, Aigerim Baimoldina, Fan Yang, Patrick Altemose, Cliff Kowall, Tao Hung

(268D) THREE DIMENSIONAL PRINTING (3DP) FIXED-BED UNIT OPERATIONS: FUTURE MANUFACTURING TECHNIQUES 216
James K. Ferri, Robert McMillin III

(565A) 3D PRINTED POLYMER/NANOPARTICLE LAYERED STRUCTURES 217
Sayli Jambhulkar, Weiheng Xu, Dharneedar Ravichandran, Yuxiang Zhu, Kenan Song

(565B) ELECTRON TUNNELING AND MECHANICAL COMPRESSION OF ALIGNED 3D PRINTED STRUCTURES OF GRAPHENE AND MOS2/BN GEL 218
Vikas Berry, Philippe Poulin, Deisy Cristina Carvalho Fernandes

(565C) XPCS STUDIES OF A CELLULOSE NANOCRYSTAL THERMOSET INK DURING EXTRUSION PRINTING 219
Roneisha Haney, Bianca Mitchell, Lutz Wiegart, Hilmar Koerner, Subramanian Ramakrishnan

(565D) 2D-STATIONARY COMPUTATIONAL PRINTING OF CEMENT-BASED PASTES. 220
Abdul Salam Mohammad, Joseph J. Biernacki

(565E) LIQUID METAL MICROPARTICLE-BASED POLYMER NANOCOMPOSITES AND THEIR 3D PRINTING 221
Sepehr Nesaei, Ruchira Tandel, Arda Gozen

(565F) 3D-PRINTING OF SELF-HEALING POLYMER COMPOSITES 223
Vinita Shinde, Bryan Beckingham, Asha-Dee Celestine

(565G) DUAL-LAYER FILAMENT FOR MATERIAL EXTRUSION ADDITIVE MANUFACTURING 224
Rebecca Ruckdashel, Jay Park

(574A) DEVELOPMENT OF A NOVEL BIOPROCESS FOR CO2 CONVERSION TO BIOCHEMICALS USING SYNTHETIC DESIGNED PROTEINS AND NON-GROWING CELLS 225
Nadim Massad, Scott Banta, Jonathan Preston, Eskil Andersen, Aleksandr Uvaydov, Ronald Koder

(574B) PARTIAL OXIDATION OF METHANE TO VALUE-ADDED PRODUCTS OVER IRON OXIDE NANOCATALYSTS 226
Jake Heinlein, Euan Gillham, Yulian He, Lisa D. Pfefferle, Shu Hu

(574C) COMPREHENSIVE PROCESS MODELING FOR CONVERTING NATURAL GAS TO LOWER OLEFIN VIA REFORMING AND FISCHER-TROPSCH PROCESS 227
Nitish Mittal, Jeffrey Camacho Bunquin, Keith Kuechler, Glenn Wood

(574D) SIMULTANEOUS ACTIVATION OF METHANE (CH4) AND NITROGEN (N2) IN A MICROWAVE-ENHANCED CATALYTIC REACTION: A COMBINED DFT MODELLING AND EXPERIMENTAL STUDY 228
Sarojini Tiwari, Tuhin Suvra Khan, Jianli Hu

(574E) CH4 TRANSFORMATION TO FUELS BY PHOTOCATLYSIS: RATIONAL DESIGN OF CATALYSTS 230
Junwang Tang, Jijia Xie

(603A) BIG DATA-BASED FAULT DETECTION WITH ADVANCED ANALYTICS IN THE PHARMA INDUSTRY 231
Deniz Koç, Daniel Castro-Rodriguez, Dimitrios I. Gerogiorgis

(603B) RECENT ADVANCES IN KINETIC PARAMETER ESTIMATION TOOLKIT (KIPET) WITH SPECTRA 233
Kevin McBride, Michael Short, Weifeng Chen, Kuan-Han Lin, David Thierry, Salvador García-Muñoz, Lorenz Biegler

(603D) TEACHING COMPUTERS TO INTERPRET MDSC THERMOGRAMS 234
Pedro Monteiro, Teresa Marta

(603E) DATA-SMART MACHINE LEARNING METHODS FOR PREDICTING YOUNGS MODULUS OF DIRECTLY COMPRESSED BLENDS OF PHARMACEUTICAL POWDERS 235
Stephen Thomas, Hossein Amini, Venkata Bobba, Hannah Palahnuk, Jaya Malladi, Ilgaz Akseli

(603G) ADVANCES AND NEW DEVELOPMENTS ON EIOT FOR PAT APPLICATIONS IN PHARMACEUTICAL DEVELOPMENT AND MANUFACTURING 236
Salvador García-Muñoz

(611A) NEW CARBON AND ZEOLITE STRUCTURED ADSORBENTS MADE FROM EXPANDED PTFE 237
Sulaimon A. Adegunju, Ryan T. Sanders, Charles E. Holland, Armin D. Ebner, James A. Ritter, Guo Shiou Foo, Robert P. Grasso, Steve K. Stark, James R. Hanrahan, Joe W. Henderson

(611B) 3D-PRINTED ACTIVATED CARBON WITH CONTROLLED POROSITY FOR REMOVAL OF TOXIC CHEMICALS FROM CONTAMINATED WATER 238
Mansour Alsalbokh, Shane Lawson, Ali Rownaghi, Fateme Rezaei

(611C) NOVEL POLYMERIC FIBER SORBENTS EMBEDDED WITH POROUS ORGANIC CAGES 239
Isaiah Borne, Stephen J. A. Dewitt, Donglin He, Ming Liu, Christopher Jones, Ryan P. Lively

(611D) MODELING AND OPTIMIZATION OF STRUCTURED CONTACTOR ADSORPTION PROCESSES BASED ON BREAKTHROUGH EXPERIMENTS 240
Seongbin Ga, Fengyi Zhang, Ryan P. Lively, Matthew Realff

(611E) CO2 CAPTURE USING 3D PRINTED PEI ADSORBENTS SUPPORTED BY CARBON NANOSTRUCTURES 241
Shreenath Krishnamurthy, Richard Blom, Carlos Grande, Vesna Middelkoop, Marleen Rombouts, Adolfo Benedito Borras

(611F) HEAT INTENSIFICATION OF TSA PROCESSES WITH PACKED METAL FOAMS: AN EXPERIMENTAL AND MODELING STUDY APPLIED TO POST-COMBUSTION CO2 CAPTURE 243
Stefano E. Zanco, Matteo Ambrosetti, Gianpiero Groppi, Enrico Tronconi, Marco Mazzotti

(616B) 4D PRINTING OF MOISTURE RESPONSIVE CELLULOSE NANOCRYSTAL POLYMER COMPOSITES 246
Michael J. Bortner, Earl J. Foster, Jacob Fallon, Tyler Seguine

(616C) EVALUATING RESIDUAL STRESS IN 3D PRINTED PARTS 247
Xiao Kuang, Burcin Ikizer, Shayuan Weng, Nese Orbey, Jerry Qi

(616D) TUNABLE STRUCTURAL COLOR OF BOTTLEBRUSH BLOCK COPOLYMERS THROUGH DIRECT-WRITE 3D PRINTING FROM SOLUTION 248
Bijal Patel, Ying Diao

(616E) 3D MICRO-EXTRUSION OF HIERARCHICAL POROUS STRUCTURES FOR SORPTION AND CATALYSIS 249
Marleen Rombouts, Ben Sutens, Yoran De Vos, Vesna Middelkoop, Jasper Lefevere, Bart Michielsen, Jo Verwimp

(616F) RAPID DIFFRACTION LIMITED PHOTO-LITHOGRAPHY OF ORGANIC SEMICONDUCTORS 250
Tucker Murrey, Goktug Gonel, Meghna Jha, Zhengliang Su, Costas Grigoropoulos, Adam J. Moulé

(616H) KINETIC ANALYSIS OF DEGRADABLE RESINS IN DIGITAL LIGHT PROCESSING 251
Whytneigh R. Duffie, Eswar Arunkumar Kalaga, Tsvetanka S. Filipova, Timothy M. Brenza, Katrina J. Donovan, Travis W. Walker

(679A) DEVELOPMENT OF A COST-EFFECTIVE AND MODULAR CLOSED LOOP PROCESS FOR METHANOL PRODUCTION IN WASTEWATER TREATMENT PLANTS 252
Pradeepkumar Sharma, Sameer Parvathikar, John R. Carpenter

(679B) DETERMINING MATERIALS SPECIFICATIONS BASED ON TECHNOECONOMIC AND LIFE CYCLE ASSESSMENT: A CASE ON OXYGEN CAREER MATERIAL FOR CHEMICAL LOOPING STEAM METHANE REFORMING 254
Yasuhiro Fukushima, Alexander Guzman-Urbina, Hajime Ohno, Kakeru Ouchi

(679C) MINIMIZATION OF CAPITAL AND OPERATING COSTS IN COOLING WATER DISTRIBUTION SYSTEMS 255
Ricardo F. F. Pontes, Beatriz L. B. C. Macedo

(679F) ECONOMIC EVALUATION OF WASTEWATER TREATMENT PLANT CONSTRUCTION IN SMALL COMMUNITIES 256
Nolan Kelly, Peipei Chen, Yunting Zhu, Jiaqi Zhu, Jennifer Escobar

(689A) IN SITU NANOMETROLOGY OF DIGITAL LIGHT PROCESSING ADDITIVE MANUFACTURING 257
Jason P. Killgore

(689B) THERMALLY AGED POLY(PHENYLENE SULFIDE) POWDER AS A FEEDSTOCK FOR POWDER BED FUSION 258
Camden A. Chatham, Arit Das, Timothy E. Long, Michael J. Bortner, Christopher B. Williams

(689C) UPCYCLING WASTE POLYESTERS TO POLYMERS FOR ADDITIVE MANUFACTURING 259
Chen Wang, Ana R. C. Morais, Erika Erickson, Nicholas A. Rorrer, Scott Nicholson, Avantika Singh, Alberta Carpenter, Alberta Carpenter, Gregg T. Beckham

(689D) ONE-LAYER ALKYLATED POLY(OLEFIN) WATER VAPOR BARRIERS AS FLEXIBLE SUBSTRATE COATINGS 260
Manos Gkikas

(689E) NUMERICAL MODELING OF A FUSED DEPOSITION MODELED EMBEDDED POLYMER FIBER IN A MICRO-DISPENSED CLADDING FOR OPTICAL FIBER INTERCONNECTS 261
Roger B. Tipton, Dianhao Hou, Thomas M. Weller, Venkat Bhethanabotla

(689F) HIGH TG AND TOUGHNESS MATERIALS FOR MASK-PROJECTION STEREOLITHOGRAPHY VIA IN-SITU SEQUENTIAL INTERPENETRATING NETWORK 262
Anh Huynh, Nicolas J. Alvarez, Giuseppe Palmese

(689G) FUSED FILAMENT FABRICATION OF HOT MELT ADHESIVES 263
Amy M. Peterson, Masoumeh Pourali

(375A) MODELING AND NONLINEAR STATE ESTIMATION FOR ADVANCED PROCESS CONTROL OF THE ENZYMATIC CONVERSION OF LACTOSE INTO VALUE-ADDED PRODUCTS 264
Ronald Alexander, Guilhermina Schultz, Marcelo P. A. Ribeiro, Fernando V. Lima

(375B) DESIGNING DATA-BASED AND MODEL-BASED METHODS FOR PROCESS MONITORING AND EQUIPMENT DEGRADATION TRACKING 266
M. Ziyan Sheriff, M. Nazmul Karim, Costas Kravaris, Hazem Nounou, Mohamed Nounou

(375C) OPTIMAL SENSOR NETWORK DESIGN AND NONLINEAR STATE ESTIMATION FOR IN-SITU CORROSION MONITORING IN COAL-FIRED BOILERS 267
Chandra Sekhar Somayajula, Debangsu Bhattacharyya, Xingbo Liu

(375D) CO2 INJECTION MONITORING WITH A SCALABLE, AUTOMATED SPARSE SEISMIC ARRAY 269
Cesar Barajas-Olalde, Donald Adams, Lu Jin, John A. Hamling, Nicholas Bosshart, Wesley D. Peck

(375E) WHAT MAKES SENSORS THE BASIS OF ANY DIGITAL TRANSFORMATION? 270
Jonas Norinder

(375G) AN EXPLAINABLE ARTIFICIAL INTELLIGENCE BASED APPROACH FOR INTERPRETATION OF FAULT DETECTION RESULTS FROM DEEP NEURAL NETWORKS 271
Venkatesh Pakkiriswamy, Rajagopalan Srinivasan

(326A) LOW-TEMPERATURE CHEMICAL LOOPING OXIDATIVE DEHYDROGENATION OF ETHANE FOR MODULAR ETHANE TO LIQUIDS 273
Luke Neal, Leo Brody, Vasudev Pralhad Haribal, Yunfei Gao, Fanxing Li

(326B) ETHANE OXIDATIVE DEHYDROGENATION IN MICROWAVE-HEATED FIXED BED AND STRUCTURED CATALYST REACTORS 274
Weiqi Chen, Kewei Yu, Abhinav Malhotra, Weiqing Zheng, Ignacio Julian, Jose M. Catala-Civera, Jesus Santamaria, Dionisios G. Vlachos, Dionisios G. Vlachos

(326C) GAS TO LIQUID FLOW REACTOR FOR CONVERSION OF BIOGAS OR WASTE METHANE TO ORGANIC ACIDS WITH HYDROGEL-ENCAPSULATED METHANOTROPHS AS FIXED BIOCATALYSTS 275
Nathan C. Ellebracht, Fang Qian, Samantha Ruelas, Joshua R. Deotte, Hawi Gemeda, Jennifer M. Knipe, Michael T. Guarnieri, Sarah Baker

(326D) TECHNO-ECONOMIC ANALYSIS OF DIRECT METHANE AROMATIZATION FOR NATURAL GAS UPGRADING AT ISOLATED SITES 276
Michael Sees, Yujeng Lin, Chau-Chyun Chen, Sheima J. Khatib

(326E) ADVANCED NANOCOMPOSITE MEMBRANES FOR NATURAL GAS PURIFICATION 277
Jaesung Park, Matthew R. Hill, Benny D. Freeman

(706A) IRON OXIDE SUPPORTED ON SILICALITE-1 AS A MULTIFUNCTIONAL MATERIAL FOR BIOMASS CHEMICAL LOOPING GASIFICATION AND SYNGAS UPGRADING 278
Xin Li, Lijun Wang, Bo Zhang, Afsaneh Khajeh, Abloghasem Shahbazi

(706B) EVALUATION OF THE IRON-BASED MATERIAL WITH AL2O3/ZRO2 ADDITION AS OXYGEN CARRIER APPLIED IN CHEMICAL LOOPING PROCESS 279
Chingti Kao, Juiyen Cheng, Chenghsien Shen, Houpeng Wan

(706C) FEASIBILITY ANALYSIS OF CHEMICAL LOOPING AMMONIA SYNTHESIS FROM STRANDED NATURAL GAS. 290
Laron Burrows, George M. Bollas

(706D) OXYGEN VACANCY HEALING FOR DESORPTION OF STORED AMMONIA FROM A METAL/ZEOLITE NANOCOMPOSITE 292
James M. Crawford, Ryther Anderson, Diego Gomez Gualdron, Moises A. Carreon

(706E) A MOLTEN CARBONATE SHELL MODIFIED PEROVSKITE REDOX CATALYST FOR ANAEROBIC OXIDATIVE DEHYDROGENATION OF LIGHT ALKANES 293
Yunfei Gao, Xijun Wang, Junchen Liu, Fanxing Li

(706G) SOLAR DRIVEN IRON OXIDE BASED THERMOCHEMICAL METHANE REFORMING AND WATER SPLITTING FOR H2 AND SYNGAS PRODUCTION 295
Rahul Bhosale, Suliman Rashid

(706H) KINETIC STUDIES ON CHEMICAL LOOPING – OXIDATIVE DEHYDROGENATION OF ETHANE USING SURFACE MODIFIED MIXED OXIDES 296
Yuan Tian, Ryan B. Dudek, Leo Brody, Luke Neal, Phillip R. Westmoreland, Fanxing Li

(731A) CATALYTIC PYROLYSIS OF WASTE AUTOMOBILE TIRES TO LOW SULFUR FUELS 297
Foster Agblevor, Oleksandr Hietsoi, Sedat H. Beis, Hossein Jahromi

(731B) PROBABILISTIC ANALYSIS OF CONVERTING MARINE-BORNE PLASTICS INTO USABLE FUELS 298
Elizabeth Belden, Michael T. Timko, Nikolaos Kazantzis

(731C) STRUVITE RECOVERY FROM MANURE BY WAY OF HYDROTHERMAL CARBONIZATION 299
Saeed Vahed Qaramaleki, Charles Coronella

(731D) CONVERSION OF RECYCLED DRYWALL INTO NITROGEN EFFICIENT FERTILIZERS 300
Jonas Baltrusaitis

(731E) SYNTHESIS AND CHARACTERIZATION OF IMPROVED ENERGY MATERIALS FROM SPENT LITHIUM-ION BATTERY CATHODES 301
Ankit Verma, David R. Corbin, Mark B. Shiflett

(731F) UPGRADING BIOCHAR VIA CO-PYROLYSIS OF AGRICULTURAL BIOMASS AND SPENT TIRES/SULFUR WASTES FOR ENVIRONMENTAL REMEDIATION 302
Seokyoung Oh, Yongdeuk Seo, Junhwan Kim, Hyungwoo Lee, Dokyoum Kim

(731G) SYNTHESIS OF NITROGEN-CONTAINING CARBON DOTS AS FE (III) PROBE AFTER EXTRACTING HUMIC ACID FROM COMPOST OF SLUDGE AND LEAF 303
Yan Zhu, Yong Liu, Ying Bao, Chuang Xie

(731H) STRUCTURAL CHARACTERIZATION AND MOLECULAR REPRESENTATION OF REFINED UNBURNED CARBON RECOVERED FROM FLY ASH 305
Yash Jaiswal, Sunderlal Pal

(733A) PLANNING AND OPTIMIZATION OF A REGIONAL HYDROGEN SUPPLY CHAIN: AN ASEAN CASE STUDY 307
Xiaodong Hong, Vaishali B. Thaore, Iftekhar A. Karimi, Farooq Shamsuzzaman, Farooq Shamsuzzaman, Xiaonan Wang, Adam K. Usadi, Bryan R. Chapman

(733B) PREDICTING REACTION MECHANISM OF ELECTROCHEMICAL CO2 REDUCTION USING MACHINE LEARNING 308
Aditya Prajapati

(733D) REVEALING THE MECHANISM OF INTRIGUING PREDOMINANT UREA FORMATION FROM THERMAL DEGRADATION OF CO2-LOADED AQUEOUS ETHYLENEDIAMINE 309
Bohak Yoon, Gyeong S. Hwang

(733E) TECHNO-ECONOMIC AND SUSTAINABILITY ANALYSIS OF THE PRODUCTION OF ACETIC AND FROM METHANE AND CARBON DIOXIDE 311
Marco Avendano, Mahmoud El-Halwagi

(733F) AN OVERVIEW OF RECENT EFFORTS UNDER THE DEPARTMENT OF ENERGY'S CARBON STORAGE PROGRAM: CARBONSAFE 312
Mary Sullivan, Kanwal Mahajan, Darin Damiani, Tomas Mora

(195A) TOWARDS THE DEVELOPMENT OF DIGITAL TWIN FRAMEWORK FOR CONTINUOUS PHARMACEUTICAL MANUFACTURING: REAL-TIME MODEL MAINTENANCE AND SYSTEM ANALYSES 337
Pooja Bhalode, Yingjie Chen, Marianthi Ierapetritou

(195B) DIGITAL TRANSFORMATION OF UNIT OPERATIONS LABORATORY 339
David Henthorn

(195C) DEVELOPMENT OF A JOINT INFRASTRUCTURE FOR CHEMICAL ENGINEERING APPLICATIONS RELATED TO INDUSTRY 4.0 AND DIGITAL TRANSFORMATION 340
Selorme Agbleze, Willy Araujo, Heleno Bispo, Fernando V. Lima

(195D) ROBUST LARGE-SCALE STATE-ESTIMATE PREDICTION 342
Leila Samandari Masooleh, Ulku Oktem, Warren Seider, Jeffrey E. Arbogast, Masoud Soroush

(229B) THE DIGITAL TRANSFORMATION OF THE CHEMICALS INDUSTRY - AND HOW TO PREPARE 344
Michael Holman

(229C) DRIVING THE VALUE FROM DIGITALIZATION 345
Billy Bardin

(229D) COMBINING AI WITH CHEMICAL ENGINEERING FIRST PRINCIPLES WILL TAKE PROCESS PERFORMANCE, SAFETY AND SUSTAINABILITY TO NEW LEVELS 346
Ron Beck

(229E) DESIGNING MATERIALS AND PROCESSES IN THE DIGITAL WORLD 347
Rob Kieschke

(195E) DIGITALIZATION OF BIOPHARMACEUTICAL MANUFACTURING 348
Moo Sun Hong, Amos E. Lu, Richard Braatz

(195F) STEPPING TOWARDS THE INDUSTRIAL SIXTH SENSE 349
Bogdan Dorneanu, Mohamed Heshmat, Abdelrahim Mohamed, Hang Ruan, Pei Xiao, Yang Gao, Harvey Arellano-Garcia

Author Index