Mechanism Understanding for NOx storage, release and reduction on Pt doped Ceria based Catalysts

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Introduction

The introduction of increasingly more stringent regulations for tailpipe emissions of lean-burn gasoline and diesel engines presents the need for further optimisation of existing after-treatment technologies. These legislations focus primarily on the reduction of NOx at low temperature, i.e., during the cold start period of engine operation.[1] High surface area ceria is successfully employed as an excellent support of PGMs in commercial catalytic LNT (Lean NOx Trap) systems for automotive emission control. Platinum supported on ceria shows enhanced NOx storage at low temperatures (150-300˚C), together with improved hydrocarbons light-offs. The OSC (Oxygen Storage Capacity) of ceria can be further enhanced using dopants. Their main function is to allow the catalyst to function outside of the normal working temperature range and widen the operating conditions to increase catalyst efficiency.[2] To this end, Samarium was selected as the doping element because of its reported effect on Pt reducibility and the Pt-ceria interaction, which allow for higher storage capacity during lean operation as well as enhanced activation during rich purge. Sm doped catalysts (10 wt.%) were synthesised on a range of ceria-based catalysts with increasing loadings of Pt (0-1 wt.%). The objective of this study was to investigate the effect of the dopant on the performance of the different catalysts, and, to correlate their reactivity with the morphological changes observed on the surface.

Materials and Methods

Catalytic benchmark testing was performed using lean/rich switching conditions to best represent real-driving conditions. 20 cycles were performed at each temperature hold to achieve a steady-state storage and conversion. The switching frequency used was 120s lean to 10s rich. Lean phase gas conditions included a complex mixture of 12% O_2, 5% CO_2, 5% H_2O, 60 ppm NO, 400 ppm C_3H_6 and 1500 ppm CO. Rich phase conditions included a mixture of: 1.5% O_2, 5% CO_2, 5% H_2O, 60 ppm NO, 1500 ppm C_3H_6 and 3% CO (balance Ar). Cycles were completed at 150, 200, 250 and 300˚C. Experiments were operated with a space velocity of 30000 h^{-1}, using a flow rate of 200 ml/min. Measurements were performed online using a Pfeiffer OmniStar™ Vacuum Mass Spectrometer. H_2-TPR experiments were performed using a MicroActive AutoChem II 2920 Chemisorption Analyser. The catalysts were pretreated for 1 hour at 500°C in 10% O_2/He (35ml/min). Hydrogen uptake was measured during a heating rate of 10°C/min, from 0°C to 1000°C in 5%H2/Ar (35ml/min).

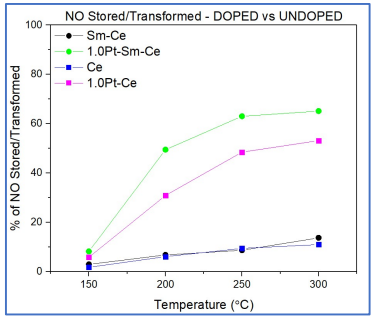
Results and Discussion

Results from lean/rich cycles illustrated in Figure 1, show that the addition of 10wt.% Sm dopant on a 1wt.% Pt-Ceria catalyst increases the NOx stored from 31% to 50%, at the low temperature (200˚C). The presence of Sm dopant also increases the amount of HC (C_3H_6) oxidised at low temperature (200ºC) by around 26% (not presented). A similar dopant behavior was also observed at lower Pt loading (0.25 wt.%). The effect of the dopant on the enhancement of the lean NOx storage capacity and HC oxidation, at temperatures above 250˚C, was more prevalent at lower Pt loading (0.25wt.%) although the total NOx stored was reduced.

To further characterise the dopant effect on NOx storage and oxidation capability, many characterisation methods were used; one of which, H_2-TPR, is interpreted here. The results are depicted in Figure 2 below. The industrial Ce support, shows the expected H_2 consumption peaks, from ~200 – 600ºC and above 700ºC which correspond to the surface and bulk reductions of ceria, respectively. 10wt.% Sm addition to the industrial ceria catalyst (Sm-Ce) results in a surface reduction profile modification to produce more intense peaks between 250-600˚C. As well as these surface changes, there is a shift in the bulk reduction temperature ranges and peak profiles to lower temperatures. We can also see from the intermediate-high temperature range (~600 – 750˚C) a noticeable difference between doped and undoped ceria catalysts, such that, the doped catalyst continues to reduce in this range unlike the undoped sample. This may indicate mixed phase reduction on the Sm doped catalyst.

TPRs of PGM loaded samples show that when Pt is present on the catalyst, (1.0Pt-Ce) an initial set of intense peaks, in the range ~ 0 – 250ºC, is produced. This can be attributed to the reduction of the metal as well as the reduction of ceria in close contact with the metal on the surface of the catalyst. The bulk reduction remains generally unaffected, with a slight increase in the amount of H_2 consumed. The incorporation of Sm to this Pt loaded catalyst (1.0Pt-Sm-Ce) does not significantly modify the initial reduction temperature ranges, however, there is an indication of the dopant effect on the Pt-Ceria interaction. Low temperature peaks are not overlapped and a further peak, occurring at low – intermediate temperatures (~300 – 550ºC), can be observed.

From these experiments it is evident that the presence of Sm results in morphological changes to Ce-based catalysts both with and without the presence of a noble metal. The link between this structural modification and the increase in NOx storage capacity has been also investigated.



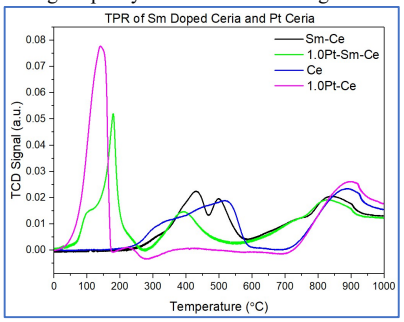


Figure 1 & 2 (LtoR). (1) NO stored/transformed during lean gas flow at a temperature range from 150-300˚C for 4 catalysts (Ce, Sm-Ce, 1.0Pt-Ce & 1.0Pt-Sm-Ce). (2) H_2-TPR profile over a temperature range from 0-1000˚C for 4 catalysts (Ce, Sm-Ce, 1.0Pt-Ce, 1.0Pt-Sm-Ce).

Significance

Initial lean/rich activation testing shows that as the presence of the doping element, Samarium, on Pt-Ceria increases the NOx storage capacity of the catalyst at low temperatures (150-300˚C) and subsequently decreases the temperature needed for NOx reduction. This is particularly important for the application of these catalysts to reduce NOx emissions during cold start operation. Knowledge gained from this experimental work can help improve future catalyst development and help to meet exhaust emission limits set out in the Euro 7 legislation.

References

1. P. Forzatti et al., Diesel NOx aftertreatment catalytic technologies: Analogies in LNT and SCR catalytic chemistry, Catalysis Today, Volume 151, 2010, Pages 202–211.
2. Q. Sun, Z. Fu, and Z. Yang, Effects of rare-earth doping on the ionic conduction of CeO2 in solid oxide fuel cells, Ceram. Int., Volume 44, 2018, Pages 3707–3711.

Wednesday, 5th January			
11:00	Registration desk opens at Burleigh Court Hotel		
12:30	Lunch at Holywell Park		
13.50	Welcome – Conference commences at Holywell Park		
	Chair – Prof. Richard Catlow		
14.00	PI 01 – Prof. Andrea Russell *(Turing Lecture Theatre)*		
14.45	Coffee		
	Session A (Turing Lecture Theatre) CatalysisHub session	*Session B (Brunel/Murdoch Lecture Theatre)*	*Session C (Stephenson Lecture Theatre)*
Chair/IT	Artioli/Gunjan	Fan/Nayan	Garforth/Dipti
15.15	K1 (Foppa) (V)	O6 (V)	O13
15.35		O7	O14
15.55	O1	O8	O15
16.15	O2	O9	K2 (James)
16.35	O3	O10	
16.55	Coffee		
Chair/IT	Artioli/Oisin	Simons/Bello	Mitchell/Gary
17.25	O4	O11 (V)	K3 (Lennon)
17.45	O5 (V)	O12	
	Chair – Prof. Chris Hardacre		
18.10	PI 02 – Prof. Annemie Bogaerts *(Turing Lecture Theatre) (V)*		
20.00	Dinner		

Thursday, 6th January			
	Chair – Dr. Haresh Manyar		
9.00	PI 03 – Prof. Karsten Reuter *(Turing Lecture Theatre)(V)*		
	Session A (Turing Lecture Theatre)	*Session B (Brunel/Murdoch Lecture Theatre)*	*Session C (Stephenson Lecture Theatre)*
Chair/IT	Paterson/Gunjan RSC INTEREST GROUP APPLIED CATALYSIS session	Lennon/Nayan	Smyth/Dipti
9.50	K4 (Wells)	O24 (V)	O40
10.10		O25 (V)	O41
10.30	O16 (V)	O26 (V)	O42
10.50	Coffee		
Chair/IT	Paterson/Oisin	Wells/Sun	Weller/Reza
11.20	K5 (Garforth)	O27	O43
11.40		O28	O44 (V)
12.00	O17	O29	O45
12.20	O18	O30 (V)	K8 (Melen)
12.40	O19	O31	
13.00	Lunch		
	Chair – Prof. Graham Hutchings		
14.00	PI 04 – Prof. Charlotte Williams *(Turing Lecture Theatre)*		
14.45	Coffee		
	(Turing Lecture Theatre)	*(Brunel/Murdoch Lecture Theatre)*	*(Stephenson Lecture Theatre)*
Chair/IT	Manyar/Gunjan RSC INTEREST GROUP SURFACE REACTIVITY & CATALYSIS session	Wang/Nayan	Kondrat/Gary
15.15	O20	O32 (V)	K9 (Tu)
15.35	O21 (V)	O33	
15.55	O22 (V)	O34	O46
16.15	K6 (Minova)	O35	O47
16.35		O36	O48
16.55	Coffee		

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Chair/IT	McGregor/Gunjan	Reza/Nayan	Negahdar/Dipti
17.25	O23	O37 (V)	O49
17.45	K7 (Simons)	O38	O50 (V)
18.05		O39	O51
18.30	**Poster session**		
20.00	Conference Dinner		
Friday, 7th January			
	Session A (Turing Lecture Theatre)	*Session B (Brunel/Murdoch Lecture Theatre)*	*Session C (Stephenson Lecture Theatre)*
Chair/IT	Carmine/Gunjan	Whiston/Nayan	Smyth/Dipti
9.00	K10 (Wang)	O52 (V)	O60
9.20		O53	O61 (V)
9.40	K11 (Mino) (V)	O54	O62
10.00		O55	O63
10.20	Coffee		
Chair/IT	Manyar/Oisin	Fan/Bello	Kondrat/Gary
10.50	K12 (Mitchell)	O56	O64
11.10		O57	O65 (V)
11.30	K13 (Luque) (V)	O58 (V)	O66
11.50		O59	O67
	Chair – Prof. Matthew Davidson		
12.15	PI 05 – Prof. Anthony Green *(Turing Lecture Theatre)*		
13.00	Closing remarks (Matthew Davidson)		

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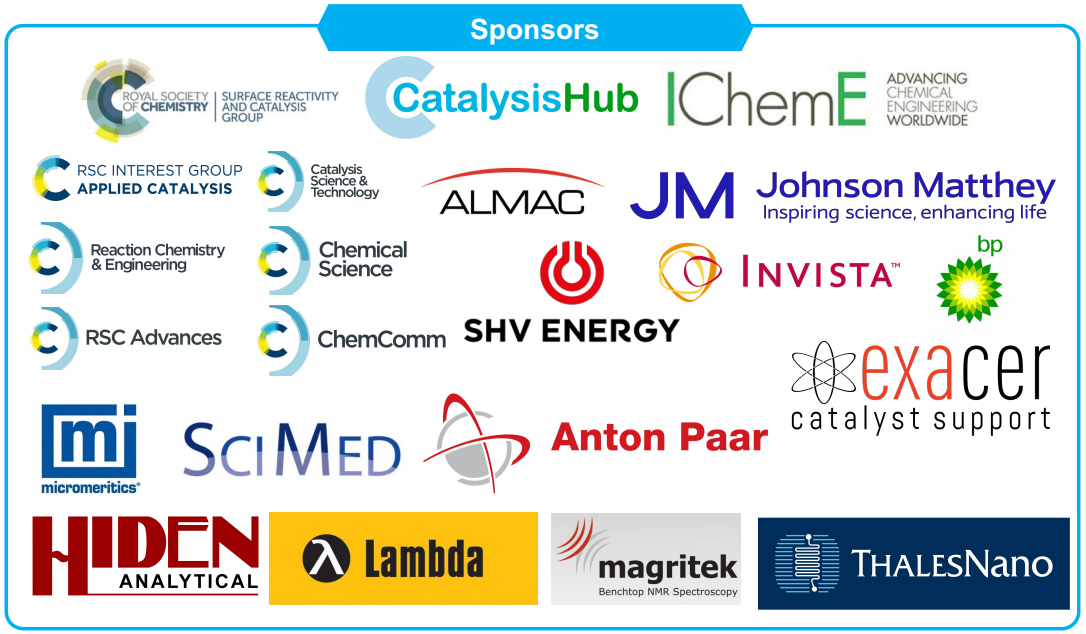

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List of Talks UKCC 2022

#	Title	Authors
Pl 01	Understanding the role of Sn and Sn oxides in CO oxidation on PtSn electrocatalysts	Andrea Russell
Pl 02 (V)	Plasma and plasma catalysis for CO_2, CH_4 and N_2 conversion: A hot topic of cold plasma!	Annemie Bogaerts
Pl 03 (V)	Data-Enhanced Multiscale Theory for Operando Catalysis	Karsten Reuter
Pl 04	Synergy and Switches in Polymerization Catalysis to Make Sustainable Elastics and Plastics	Charlotte Williams
Pl 05	Design and Evolution of Enzymes with New Function	Anthony Green
K 01	Materials genes of heterogeneous catalysis from clean experiments and artificial intelligence	Lucas Foppa
K 02	Mechanochemistry and Catalysis	Stuart James
K 03	The STFC ISIS Neutron and Muon Source Economic Impact Award 2021	David Lennon
K 04	Spatially resolved methods for operando catalysis	Peter Wells
K 05	Chemical Recycling of Problematic Plastics	Arthur Garforth
K 06	Applying Synchrotron Infrared Microspectroscopy to Understand Methanol-to-Hydrocarbons Catalysis in Zeolites	Ivalina Minova
K 07	On-Purpose production to LPG and DME from sustainable feedstocks	Keith Simons
K 08	Lewis Acidic Boranes as Catalysts for Carbene Transfer Reactions	Rebecca Melen
K 09	Plasma Catalysis: An Emerging Technology for Power-to-X	Xin Tu
K 10	Dynamics of Cu-O bond breaking over Ceria surface	Ryan Wang
K 11 (V)	Unravelling the crucial role of surface features behind facet-dependent photocatalytic processes in TiO_2 anatase nanoparticles	Lorenzo Mino
K12	Laboratory scale testing of formed catalyst particles	Chris Mitchell
K13 (V)	Benign-by-design nanomaterials for sustainable catalytic applications	Rafael Luque

O 01	Synthesis of semi-aromatic polyamides based on renewable 2,5-furandicarboxylic acid (FDCA)	Muhammad Kamran, Matthew Davidson and Sicco De Vos
O 02	Low-energy destruction of organics in high salinity shale gas brines	Mbongiseni William Dlamini, Samuel Pattisson, Philip R. Davies, Graham J. Hutchings and Christopher Hardacre
O 03	Nanoparticle loaded Metal–organic frameworks for room-temperature direct decomposition of NO_2 by non-thermal plasma	Shaojun Xu, Emma K. Gibson and Richard Catlow
O 04	Upgrading Volatile Fatty Acids to biofuels using Sulfated CeO_2-ZrO_2 Catalysts: Insights into Homo vs Cross Ketonisation Pathway	Gunjan Deshmukh, Alexandre Goguet and Haresh Manyar
O 05 (V)	Photocatalytic antifouling membrane containing conjugated microporous poly(phenylene butadiynylene) for chemical-free degradation of organic micropollutants	Agnieszka Holda, Semali Perera and Emma Emanuelsson Patterson
O 06 (V)	Single-Reactor Tandem Oxidation-Amination Process for the Synthesis of Furan Diamines from 5-Hydroxymethylfurfural	Marc Pera-Titus, Jin Sha, Bright T. Kusema, Wen-Juan Zhou, Zhen Yan and Stephane Streiff
O 07	Developing Silicalite-1 encapsulated Ni nanoparticles as anti-sintering-/coking catalysts for dry reforming of methane	Shanshan Xu, Thomas J.A. Slater, Xiaolei Fan and Christopher Hardacre
O 08	Evaluating Perovskite-Based Pt Catalysts in the Aqueous Phase Reforming of Glycerol	Donald Inns, Alexander Mayer, Vainius Skukauskas, Thomas Davies, June Callison and Simon Kondrat
O 09	Gas phase valorization of glycerol over ceria nanostructures with well-defined morphologies	Louise Smith
O 10	Selective Hydrogenation of Levulinic Acid to γ-Valerolactone using Copper Supported on Manganese Oxide Molecular Sieves as Catalysts	Nayan Jyoti Mazumdar, Anna Rovea, Gunjan Deshmukh, Praveen Kumar, Miryam Arredondo-Arechavala and Haresh Manyar
O 11	Ni or Fe-Investigation on integrated CO_2 capture and Reverse water-gas shift reaction	Shuzhuang Sun, Su He, Chen Zhang and Chunfei Wu
O 12	Development of Solid Acid Catalysts for Biofuels	Cameron Alexander Price and Christopher Parlett
O 13	Bringing closer hydrogenation and reforming by exploring the use of NiRu catalysts in flexible CO_2 utilisation schemes	Loukia-Pantzechroula Merkouri, Estelle le Sache, Laura Pastor Perez, Melis Duyar and Tomas Ramirez Reina
O 14	Identifying the catalytic properties which drive oxidative dehydrogenation and dehydration in aerobic glycerol oxidation.	Max Tigwell, Mark Douthwaite, Louise Smith, Nicholas Drummer, Matthew

		Conway, Stuart Taylor and Graham Hutchings
O 15	Conversion of CO_2 to acetate and multi-carbon carbohydrates by Microbial electrosynthesis (MES)	Eileen Yu, Paniz Izadi, Jean-Marie Fontmorin and Da Li
O 16	Cooperative Chemobio-Catalysts for Selective Hydrogenations	Tim Sudmeier, Sarah Cleary, Simon Freakley and Kylie Vincent
O 17	Montmorillonite based clay catalysts for oleochemical processing	Oscar Kelly, Callum Morris, Adam Mudashiru and Adam Brookbanks
O 18	An Inelastic Neutron Scattering Investigation of the Temporal Behaviour of the Hydrocarbonaceous Overlayer of a Prototype Fischer-Tropsch to Olefins Catalyst	Alisha Davidson, Emma K. Gibson, Hendrik van Rensburg, Paul Webb, Stewart F. Parker and David Lennon
O 19	The Development of Kinetic Models for Phosgene Synthesis Over Activated Carbon Catalysts	Rory Hughes, Giovanni Rossi and David Lennon
O 20	Towards high selectivity aniline synthesis catalysis at elevated temperatures	Annelouise McCullagh, Clement Morisse, James Campbell, Colin How, Donald MacLaren, Robert Carr, Chris Mitchell and David Lennon
O 21 (V)	Cu-Ni Nanometals Supported over Mesocellular Silica Foam as Novel Bimetallic Catalyst for One-pot Synthesis of Benzimidazole in DMF as Bifunctional Reagent	Shalaka S. Mohire and Ganapati D. Yadav
O 22 (V)	Increasing Al-pair abundance in SSZ-13 zeolite via zeolite synthesis in the presence of alkaline earth metal hydroxide produces hydrothermally stable Co(II), Pd(II) and Cu(II) SSZ-13 materials	Konstantin Khivantsev, Miroslaw A. Derewinski, Nicholas R. Jaegers, Yong Wang and Janos Szanyi
O 23	Effect of graphene oxide surface properties on the catalytic performance for the oxidation of benzyl alcohol	Min Hu, Heng Liu and Carmine D Agostino
O 24 (V)	On the nature of extra-framework aluminum species and improved catalytic properties in steamed zeolites	Konstantin Khivantsev, Nicholas Jaegers, Ja-Hun Kwak, Miroslaw Derewinski, Janos Szanyi and Libor Kovarik
O 25 (V)	Zeolite stabilized molybdenum sulfide clusters activate hydrogen as hydride species and form stable catalytic hydrogenation sites	Rachit Khare, Roland Weindl, Andreas Jentys, Karsten Reuter, Hui Shi and Johannes A. Lercher
O 26 (V)	Phase and facet-engineering of transition alumina leads to (hydro)thermally stable alumina-supported metal catalysts	Konstantin Khivantsev, Nicholas Jaegers, Janos Szanyi and Libor Kovarik

O 27	Synthesis of catalytic active sites in flow for on-demand hydrogen production from ammonia.	Joseph Kadi and Laura Torrente-Murciano
O 28	Recycling Single Use Plastics to Useful Chemical Intermediates	Nasser Alqahtani, Edidiong Asuquo, Abdulrahman Bin Jumah, Aleksander Tedstone and Arthur Garforth
O 29	Pd supported on hierarchical zeolites as the multifunctional catalyst for cascade catalysis towards biofuel synthesis	Shengzhe Ding, Christopher Parlett and Xiaolei Fan
O 30 (V)	Development of Porous Sulfated Geopolymer as Catalyst for Application in Oxidation of Dibenzothiophene	Snehlata Kumari, Sonali Sengupta
O 31	Exploring the influence of confinement and acidity in alcohol dehydrations	Matthew Potter, Stylianos Kyrimis, Robert Raja and Lindsay-Marie Armstrong
O 32 (V)	Clarification of the mechanism of NO reduction with ammonia (SCR) on zeolite catalysts	Konstantin Khivantsev, Janos Szanyi and Nicholas Jaegers
O 33	Photocatalytic reforming of lignin for production of H_2 and value-added chemicals.	Meshal Aljohani, Helen Daly, Xiaolei Fan and Christopher Hardacre
O 34	Plasma – plasmonic interaction for CO_2 conversion towards solar fuels	Joseph Gregory, Richard Walton, Volker Hessel and Evgeny Rebrov
O 35	Cu-Ag alloy nanocatalysts for multicarbon organic compounds from electrochemical CO_2 reduction	Preetam Sharma, Da Li, Ye Ma and Eileen Yu
O 36	Maximising iridium utilisation in proton exchange membrane water electrolysers	Yagya Regmi and Laurie King
O 37	Solar-light-driven Photocatalytic Degradation of Famotidine in Water using Ordered Mesoporous Titania	Parasuraman Selvam and Surya Kumar Vatti
O 38	Light-driven, heterogeneous organocatalysts for C–C bond formation toward valuable perfluoroalkylated intermediates studied using low-field 1H/19F NMR relaxation adsorption measurements	Carmine D'Agostino, Giacomo Filippini, Francesco Longobardo, Luke Forster, Graziano Di Carmine, Michele Melchionna, Paolo Fornasiero and Maurizio Prato
O 39	Effect of ball-milling and plasma pre-treatment of cellulose on its photoreforming for H_2 production	Lan Lan, Xiaolei Fan and Christopher Hardacre
O 40	Stable and Economic Iridium-Based Catalysts for Renewable Energy Technologies	Thomas Lau, Donato Decarolis, Laurie King and Yagya Regmi
O 41	Modelling a Photocatalytic CSTR for Optimisation by Periodic Operation	Thomas Ellwood, Luka Zivkovic, Petr Denissenko, Rufat Abiev, Menka Petkovska and Evgeny Rebrov

O 42	A comparison of chromatographic and electrochemical detection methods for MCPA and its primary intermediate formed during photocatalytic degradation.	Clare Rice, Peter Robertson, Nathan Skillen and Denis McCrudden
O 43	3D Printed Zeolites in Aromatic Transalkylation	Hisham Hussain, Abdullah Alhelali, Aleksander Tedstone, Callum Davidson, Arthur Garforth and Aidan Doyle
O 44 (V)	Pickering interfacial catalysis in oil foams	Marc Pera-Titus, Shi Zhang and Dmytro Dedovets
O 45	3D Printed Zeolite Monolith for Low Wood Stove Emissions	Abdullah Alhelali, Edidiong Asuquo, Aleksander Tedstone, Daniel Wilson, Arthur Garforth and Amanda Lea-Langton
O 46	Investigating the Catalytic Fast Pyrolysis Reaction on Zeolite catalysts by Kerr-gated Raman	Emma Campbell, Igor Sazanovich, Ines Lezcano-Gonzalez, Andrew Beale, Michael Towrie and Michael Watson
O 47	Platinum supported on Titania/C Dual-function Hybrid Support Catalysts for Electrocatalytic Reduction of Benzaldehyde	Bello Isah, Udishnu Sanyal, Geetha Srinivasan, Oliver Guttierez, Johannes A. Lercher, Haresh Manyar
O 48	The Influence of Solvent Composition on the Structure-Activity Relationship of the para-Xylene Oxidation Catalyst	Rebekah Taylor, Andrea Folli, Duncan Housley, Keith Whiston, Graham Hutchings and Damien Murphy
O 49	Dynamics of Water within Copper-loaded Mordenite, ZSM-5 and SSZ-13 probed by QENS	Vainius Skukauskas, Emma Gibson and Ian Silverwood
O 50 (V)	Nature of active sites in Cu-exchanged small pore zeolites during selective catalytic reduction of nitrogen oxides with ammonia	Rachit Khare, Mirjam Wenig, Andreas Jentys and Johannes A. Lercher
O 51	Operando studies of aerosol-assisted sol-gel catalyst synthesis via combined optical trapping and Raman spectroscopy	Gareth Davies, Justin Driver, Andrew Ward, Leila Negahdar and James McGregor
O 52 (V)	Formation of HCO^+ ion by protonation of carbon monoxide in zeolites: the origin of catalytic activity in methanol carbonylation	Konstantin Khivantsev, Janos Szanyi, Ja-Hun Kwak, Nicholas Jaegers, Hristiyan Aleksandrov and Georgi Vayssilov
O 53	Unravelling Complex Oligomerization Chemistries through Microkinetic Modelling	Sergio Vernuccio
O 54	Catalytic formation of oxalic acid on the partially oxidised greigite $Fe_3S_4(001)$ surface	David Santos-Carballal and Nora H. de Leeuw
O 55	Cu, Pd and Zn surfaces for CO_2 activation and hydrogenation	Igor Kowalec, Lara Kabalan, Andrew Logsdail and Richard Catlow
O 56	Machine-powered optimisation of heterogeneous catalysts with nitrogen-based poisons	Nikolay Cherkasov

O 57	Autonomous Microfluidic Reactor Platform for Rapid Identification of Heterogeneous Catalyst Kinetics of Gas-Phase Reactions	Solomon Bawa, Arun Pankajakshan, Enhong Cao, Federico Galvanin and Asterios Gavriilidis
O 58 (V)	Catalyst oxidation reactions using a homogeneous manganese(II) catalyst and peracetic acid under continuous flow conditions	Ailbhe Ryan, Tom S. Moody, Karen Fahey, Scott Wharry, Megan Smyth, Jillian M. Thompson, Peter C. Knipe and Mark J. Muldoon
O 59	Utilising enzymes as a purification strategy following a continuous flow Curtius rearrangement	Megan Smyth, Marcus Baumann, Thomas Moody and Scott Wharry
O60	A study on transfer hydrogenation under continuous operation – The reduction of aromatic nitriles using formic acid and formates	Seán Dempsey and Jillian Thompson
O61 (V)	Exploiting Continuous Photochemical Processes for the Greener Preparation of Complex Drug-Like Entities	Marcus Baumann
O62	An Efficient, Selective and Broadly Applicable Homogeneous Catalyst for Aerobic Alkene Epoxidation	Qun Cao, Mark Muldoon and Ulrich Hintermair
O63	An Air-Stable, Easy to Assemble, Catalyst for Selective Amine-Borane Dehydropolymerisation: Mechanism, Chain Control and on-scale Polymer Production	Claire Brodie and Andrew Weller
O64	Multiscale imaging and in situ analysis of industrially relevant materials for emission control.	Monik Panchal, Emma K. Gibson, Richard Catlow, Andrew Beale, Manfred Schuster, Timothy Hyde, Andrew York and Paul Collier
O65 (V)	Mechanism Understanding for NO_x storage, release and reduction on Pt doped Ceria based Catalysts	Oisin Hamill, Nancy Artioli, Alex Goguet, Nicola Collis, Paul Millington, Jillian Collier and Loredana Mantarosie
O66	A Novel Designed Perovskite @ Spinel Nanocomposite for Efficient Oxygen Evolution in Alkaline Solution	Heng Liu, Carmine D'Agostino, Jun Pan and Yuan Wang
O67	Improving cracking of n-Dodecane over FCC catalysis: a selective route towards light olefins production	Hassan Alhassawi, Zhipeng Qie and Xiaolei Fan