

Formation of a novel Al₂O₃ surface (Al–O[★]) by plasma-excited nitrogen: O₂ production by water treatment of the Al–O[★] surface

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An uphill reaction (N₂ + 3H₂O → 2NH₃ + 3/2O₂) takes place on the Al₂O₃ surface by means of N₂ plasma treatment followed by water treatment at room temperature.

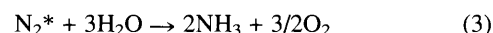
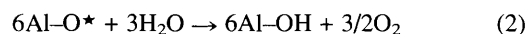
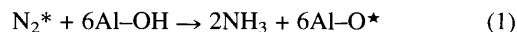
We have recently found that, when N₂ is activated by plasma discharge, nitrogen chemisorption occurred on metals (Ru, Pt) and/or oxides such as Al₂O₃ and TiO₂ at room temperature, and NH₃ was formed by the reaction of the plasma-excited nitrogen with surface OH groups on oxides, as observed by TPD, IR and XPS measurements.^{1–4} Here, we report that the surfaces of oxides such as Al₂O₃ formed by using plasma N₂ treatment are different from those formed by the usual thermal treatment of oxides,^{5,6} and the Al₂O₃ surface (after plasma N₂ treatment) was restored by water treatment, which was accompanied by O₂ generation.

An Al₂O₃ catalyst (3 mm diameter sphere, 128 m² g⁻¹) was provided by the Catalysis Society of Japan (JRC-ALO-3) and a γ-Al₂O₃ coated catalyst (200 m² g⁻¹ Al₂O₃) on a cylindrical ceramic support (diameter = 15 mm, length = 200 mm) was provided by the N. E. Chemcat Corp.⁷ Each of the Al₂O₃ catalysts was placed in the centre of a quartz reactor tube (diameter = 25 mm, length = 500 mm). In this study, the experimental procedures were as follow. (A) (i) An N₂ plasma treatment for the Al₂O₃ catalysts was performed in a flow reactor system after preheating the sample under He at 200 °C for 1 h.^{1–4} A stable plasma was obtained in the quartz reactor tube using rf (13.56 MHz, 60 W, N₂ 1 Torr) at room temperature.^{1–4} (ii) After the N₂ plasma treatment, the catalyst temperature was raised to 450 °C under an He flow, during which a liquid-nitrogen trap was used to trap the NH₃ produced, which was subsequently quantified by gas chromatography with a thermal conductivity detector (TCD).¹ (B) The Al₂O₃ sample was treated with H₂O vapour (ca. 24 Torr) at 200 °C after procedure A. (C) The Al₂O₃ sample was soaked in distilled water at room temperature after procedure A. (D) In a separate experiment, analysis of O₂ produced during water treatment of the Al₂O₃ sample (after procedure A) was performed by using a Pyrex glass tube [connected to a quadrupole mass spectrometer (QMS)] equipped with a Teflon membrane which transmits the dissolved O₂ in water.^{8,9}

As shown in Table 1, NH₃ was produced by N₂ plasma treatment followed by He treatment (run 1). The subsequent plasma treatment of the used Al₂O₃ catalyst resulted in a drastic decrease in the amount of NH₃, because of depletion of the surface OH groups in the reaction area.⁷ It is well known that the

dehydroxylated Al₂O₃ obtained by heat treatment is restored by H₂O vapour treatment [see Fig. 1(a), (b)].⁶ However, the surface of the Al₂O₃ formed by the N₂ plasma treatment was different from that obtained by usual thermal treatment on Al₂O₃, since this Al₂O₃ surface was not restored by H₂O vapour treatment (run 2, Table 1). The amount of NH₃ produced on the plasma N₂ treated surface (after H₂O vapour treatment) was < 10% of that on the fresh surface. After NH₃ was formed and desorbed by procedure A, the Al₂O₃ surface may be changed to an excess oxygen phase; *i.e.* the formation of a novel Al₂O₃ surface (designated by Al–O[★]) [Fig. 1(c)].

The recovery of the NH₃ formation rate on the N₂ plasma treated Al₂O₃ surface was possible by means of a water (liquid) treatment, as shown in Table 1 (run 3). The surface of the Al₂O₃ formed by the N₂ plasma treatment was restored by the water treatment, which was accompanied by O₂ generation (experimental procedure D). The reproducibility of this phenomenon was very good and the cycle could be repeated many times [see Fig. 1(b), (c)]. Fig. 2 shows the amount of the products [NH₃, O₂ (μmol g⁻¹ Al₂O₃)] as a function of the N₂ plasma treatment time. The result indicates a good correlation between the amount of O₂ generated and the amount of ammonia produced. It should be noted that no O₂ was produced during plasma N₂ treatment with subsequent heat treatment. We propose a surface reaction cycle [eqns. (1) and (2); overall eqn. (3)] on the surface of the Al₂O₃, where Al–O[★] indicates the H-consumed surface formed by the plasma N₂ treatment. The observed O₂/NH₃ ratio (*ca.* 0.65; see Fig. 2) is well reconciled with the stoichiometry (0.75) of the overall reaction [eqn. (3)] within 15% uncertainty. In practice, some of the O₂ produced during the water treatment may not be introduced to the QMS.¹⁰



Eqn. (1) indicates the reaction of plasma-excited nitrogen (designated as N₂^{*}) with surface OH groups to form NH₃

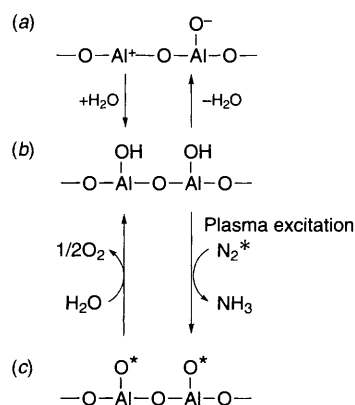


Fig. 1 Schematic representation of an Al₂O₃ surface: (a) the dehydroxylated Al₂O₃ surface after heat treatment; (b) the restored Al₂O₃ surface after water treatment; and (c) the Al–O[★] surface after N₂ plasma treatment

Table 1 The amount of NH₃ formed by N₂ plasma treatment (30 min) of the γ-Al₂O₃ coated catalyst

Run	Procedure ^a	Sample treatment	Produced NH ₃ /μmol g ⁻¹ Al ₂ O ₃
1	A	Fresh	7.11
2	A → B → A	H ₂ O (vapour)	0.53
3	A → C → A	H ₂ O (liquid)	6.02

^a See text.

(simply showing the overall stoichiometry), but the detailed mechanism is not known at the present stage.^{1-4,11} The plasma-excited nitrogen may consist of various species such as radicals (N_2^* , N^*) and ions (N_2^+ , *etc.*), and the most dominant species is N_2^* ; in particular the lifetime of N_2^* ($A^3\Sigma_u^+$ state) is relatively longer.³ However, we cannot determine which species is important in reaction (1). In any case, reaction (1) takes place after dissociation of the $N\equiv N$ bond: *e.g.* via formation of a surface Al-N species and/or adsorbed N(a) species.^{3,4} Eqn. (2) explains O_2 production upon water treatment of the Al-O*

surface and the surface is restored to the original Al-OH. In order to elucidate the mechanism of reaction (2), further experiments using labelled $H_2^{18}O$ water are now in progress in our laboratory.

The present results suggest that the formation of a novel Al_2O_3 surface by N_2 plasma treatment (activation of surface), and the normally thermodynamically uphill reaction ($N_2 + 3H_2O \rightarrow 2NH_3 + 3/2O_2$; $\Delta G_{298} = 162 \text{ kcal mol}^{-1}$; $\text{cal} = 4.184 \text{ J}$) can take place on the Al_2O_3 surface.

The authors are grateful to Professor Y. Takasu, Shinshu University, for supplying the Teflon membrane and for fruitful discussion.

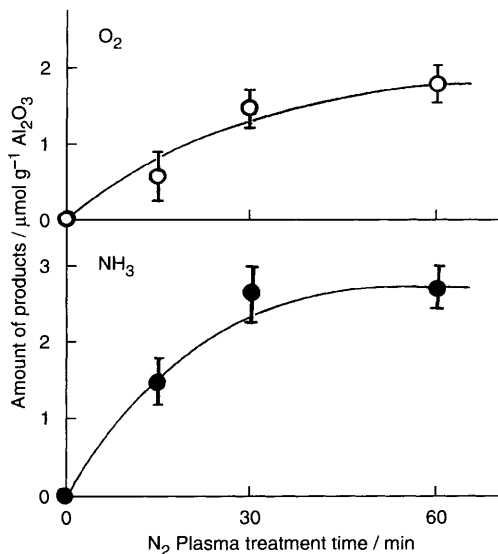


Fig. 2 The amount of O_2 and NH_3 produced on Al_2O_3 (JRC-ALO-3) as a function of the N_2 plasma treatment time

References

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Conference Diary*

September 1996

23rd Annual Conference of the Federation of Analytical Chemistry and Spectroscopic Societies, FACSS XXIII

Kansas City, USA September 29-October 4
Contact: FACSS National Office, 201-B Broadway St., Frederick, MD 21701-6501 USA.
Tel +1 301 846 4797. Fax +1 301 694 6860.

Innovative Research in Organic Chemistry

Ischia Porto, Italy September 29-October 4
Contact: Dr S Pedatella, Department of Organic and Biological Chemistry, Università di Napoli 'Federico II', Via Mezzocannone, 16, I-80134 Napoli, Italy. Tel & Fax +39 81 7041283.
E-mail iasoc@ds.unina.it

7th International Conference on Multiphoton Processes

Garmisch Partenkirchen, Germany September 30-October 4
Contact: Professor P Lambropoulos, Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, D-85748 Garching, Germany

October 1996

5th International Symposium on the Chemistry and Pharmacology of Pyridazines

Sopron, Hungary October 2-5
Contact: Dr Péter Mátyus, Institute for Drug Research, PO Box 82, H-1325, Hungary. Tel +36 1 1690011. Fax +36 1 1693229.

8th International Symposium on Heterogeneous Catalysis

Varna, Bulgaria October 5-9
Contact: R Edreva-Kardjieva, Institute of Catalysis, Bulgarian Academy of Science, 1113 Sofia, Bulgaria.

XVIIth European Colloquium of Heterocyclic Chemistry

Regensburg, Germany October 6-9
Contact: Professor G Märkl, Institut für Organische Chemie, Universität Regensburg, D-93040 Regensburg, Germany.
Tel +49 941 943 4631. Fax +49 941 943 4505.

Chiral Europe '96

Strasbourg, France October 14-15
Contact: Spring Innovations Ltd, 185A Moss Lane, Bramhall, Stockport, UK SK7 1BA.
Tel +44 (0) 161 440 0082. Fax +44 (0) 161 440 9127.

Joint RSC Fine Chemicals and Medicinals Group-SCI Cardiovascular Meeting

Edinburgh, UK October 20-22
Contact: RSC†

Recent Advances in Drugs for the Treatment of Cardiovascular Disease

Edinburgh, UK October 20-22
Contact: Elaine Wellingham, Conference Secretariat, Field End House, Bude Close, Nailsea, Bristol, UK BS19 2FQ.
Tel & Fax +44 (0) 1275 853311.

November 1996

IRaP 96 2nd International Symposium on Ionizing Radiation and Polymers

Saint-François, Guadeloupe November 3-8
Contact: Dr N Betz, Chairwoman of IRaP 96 Organizing Committee, DRECAM/SRSIM/LPI, CEA/Saclay, F-91191 Gif sur Yvette Cedex, France. Tel +33 1 69 08 48 34.
Fax +33 1 69 08 96 00.
E-mail betz@drecam.cea.fr or irap@drecam.cea.fr

International Symposium on the Industrial Application of the Mössbauer Effect

Johannesburg, South Africa November 4-8
Contact: Professor H Pollak, Mössbauer Laboratory, University of the Witwatersrand, Private Bag 3, Johannesburg, WITS 2050, South Africa. Tel +27 (11) 7164051. Fax +27 (11) 3398262.
E-mail isiame@physnet.phys.wits.ac.za

Heterocycles in Synthesis

London, UK November 11
Contact: Dr D M Hollinshead, Zeneca Pharmaceuticals, Mereside, Alderly Park, Macclesfield, UK SK10 4TG.
Tel +44 (0) 1625 514791. Fax +44 (0) 1625 586707.

XV Chemistry Conference

Santiago de Cuba, Cuba November 27-29
Contact: Dr L Ballester Gonzalez, Executive Secretary, XV Conference de Quimica, Universidad de Oriente, Santiago de Cuba 90500, Cuba. E-mail xvconf@cnm.uo.edu.cu

December 1996

14th SCI Process Development Symposium

Manchester, UK December 1-4
Contact: SCI Conference Secretariat, 14/15 Belgrave Square, London, UK SW1X 8PS. Tel +44 (0) 171 235 3681.
Fax +44 (0) 171 235 7743.
E-mail conferences@chemind.demon.co.uk

Asymmetric Catalysis

London, UK December 2
Contact: Dr D Craig, Department of Chemistry, Imperial College of Science, Technology & Medicine, London, UK SW7 2AY.
Tel +44 (0) 171 594 5771. Fax +1 (0) 171 594 5804.
E-mail d.craig@ic.ac.uk

Fifth Eurasia Conference on Chemical Sciences

Guangzhou, China December 10-14
Contact: Professor Liang-Nian Ji, Biotechnology Research Center, Zhongshan (Sun Yatsen) University, Guangzhou, Canton 510275, China. Tel +86 (20) 418 5461. Fax +86 (20) 418 9173.
E-mail leiy@bepc2.ihep.ac.cn

Faraday Discussion 105, Catalysis and Surface Science at High Resolution

Reading, UK December 16-18
Contact: Professor M Bowker, Department of Chemistry, University of Reading, Whiteknights Park, Reading, UK RG6 6AD.

*Conference Organisers are invited to send details of meetings concerning all aspects of chemistry to: Dr A P Kybett, The Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge, UK CB4 4WF. Tel +44 (0) 1223 420066. Fax +44 (0) 1223 420247. E-mail ChemComm@rsc.org

†Contact: Dr J F Gibson, The Royal Society of Chemistry, Burlington House, London, UK W1V 0BN. Tel +44 (0) 171 437 8656. Fax +44 (0) 171 734 1227.
E-mail Conferences@rsc.org

Computer Modelling Inorganic Chemicals

London, UK December 18
Contact: Dr Philip Mitchell, Department of Chemistry, University of Reading, Reading, UK RG6 6AD.
Tel +44 (0) 1734 875123 ext. 7448. Fax +44 (0) 1734 311610.
E-mail p.c.h.mitchell@reading.ac.uk

Inorganic Mechanisms Discussion Group UK Symposium

York, UK December 19-21
Contact: Professor M B Davies, Applied Sciences, Anglia Polytechnic University, East Road, Cambridge, UK CB1 1PT.
Tel +44 (0) 1223 363271. Fax +44 (0) 1223 576157.

January 1997**International Symposium on Chemical and Biological Thermodynamics**

Amritsar, India January 5-8
Contact: Professor D V S Jain, Department of Chemistry, Panjab University, Chandigarh 160014, India. Tel +91 (172) 541435.
Fax +91 (172) 541409. E-mail dvs-jain@imtech.ernet.in

13th Winter Fluorine Conference

St Petersburg Beach, USA January 19-24
Contact: ACS Meetings Department, 1155-16th St, NW, Washington DC 20036-4899, USA. Tel +1 (202) 872 6286.
Fax +1 (202) 872 6128. E-mail miscmtgs@acs.org

February 1997**10th Australasian Electrochemistry Conference**

Surfers Paradise, Australia February 4-7
Contact: Dr David Druskovich, Department of Chemistry, Central Queensland University, Rockhampton, Qld 4702.
Fax 617 930 9612. E-mail d.druskovich@ucq.edu.au

International Joint Symposium in Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas

Panama City, Panama February 23-26
Contact: Professor Kurt Hostettmann, Chairman, IOCD Working Group on Plant Chemistry, Institute of Pharmacognosy and Phytochemistry, University of Lausanne, B.E.P., CH-1015 Lausanne-Dorigny, Switzerland. Tel +41 21 692 45 61.
Fax +41 21 692 45 05.

April 1997**30th Annual International Meeting: ESR Spectroscopy of Radicals in Organic and Biological Systems and 5th International Symposium on Spin Trapping: Applications in Chemistry, Biology and Medicine**

Lancaster, UK April 6-10
Contact: Dr C C Rowlands, Department of Chemistry, University of Wales, Cardiff, PO Box 912, Cardiff, UK CF1 3TB.

Spring ACS National Meeting

San Francisco, USA April 13-17
Contact: American Chemical Society, Meetings, PO Box 18598, 20th St Station, Washington, DC 20036-8598, USA.

6th International Symposium, Chemistry in the Oil Industry

Ambleside, UK April 14-17
Contact: P Ogden, Laporte Absorbents, PO Box 2, Moorfield Road, Widnes, Cheshire, UK WA8 0JU.

May 1997**11th Noordwijkerhout-Camerino Symposium, Trends in Drug Research**

Noordwijkerhout, The Netherlands May 11-16
Contact: Secretariat 11th Noordwijkerhout-Camerino Symposium, c/o Professor H Timmerman, LACDR/Dept. of Pharmacochimistry VU, De Boelelaan 1083, 1081 HV Amsterdam, The Netherlands.

15th North American Catalysis Society Meeting

Chicago, USA May 18-22
Contact: J Miller, Amoco Corporation, PO Box 3011, Naperville IL 60566-7011, USA. Tel +1 (708) 42055818.
Fax +1 (708) 4203698 (NB. area code changes to 630 after 20 August 1996). E-mail jmiller@nap.amoco.com
WWW <http://www.anl.gov/nam/index.html>

EPDIC-5 5th European Powder Diffraction Conference

Parma, Italy May 26-28
Contact: Professor G Artoli, Dipartimento di Scienze della Terra, Università di Milano, Via Botticelli, I-20133 Milano, Italy.
Tel +39 2 23698320. Fax +39 2 70638681.
E-mail epdic@lummix.terra.unimi.it

June 1997**80th Canadian Society for Chemistry Conference and Exhibition**

Windsor, Canada June 1-5
Contact: Diane Goltz, The Chemical Institute of Canada, 130 Slater Street, Suite 550, Ottawa, ON, K1P 6E2. Tel +1 613 232 6252.
Fax +1 613 232 5862.

4th International Symposium on Bio-organic Chemistry

Biarritz, France June 1-6
Contact: Professor A Marquet, Université Paris, URA CNRS 493, Laboratoire de Chimie Organique Biologique, Tour 44/45-4 Pl. Jussieu, 75252 Paris Cedex 05, France.

5th International Symposium on Metallomesogens

Neuchâtel, Switzerland June 3-6
Contact: Professor R Deschenaux, Université de Neuchâtel, Institut de Chimie, Av. de Bellevaux 51, 2000 Neuchâtel, Switzerland.
E-mail congres.ism97@ich.unine.ch

16th Conference on Coordination Chemistry

Smolenice, Slovakia June 9-13
Contact: Professor G Ondrejovič, Department of Inorganic Chemistry, Slovak Technical University, Radlinského 9, 812 37 Bratislava, Slovakia. Tel +42 7 495257. Fax +42 7 493198.
E-mail sirota@cvstu.cvt.stuba.sk

35th National Organic Symposium

San Antonio, USA June 22-26
Contact: Dr James Rigby, Department of Chemistry, Wayne State University, Detroit, MI 48202, USA.
Tel +1 313 577 3472. Fax +1 313 577 2099.
E-mail jhr@fourcroy.chem.wayne.edu

10th European Symposium on Organic Chemistry (ESOC 10)

Basel, Switzerland June 22-27
Contact: ESOC 10, Convention Center Basel, PO Box/Messeplatz 21, CH-4021 Basel, Switzerland. Tel +41 61 686 28 28.
Fax +41 61 686 21 85.

†*Contact:* Dr J F Gibson, The Royal Society of Chemistry, Burlington House, London, UK W1V 0BN. Tel +44 (0) 171 437 8656. Fax +44 (0) 171 734 1227.
E-mail Conferences@rsc.org

71st Colloid & Surface Science Symposium

Newark, USA June 29-July 2
Contact: E W Kaler, Department of Chemical Engineering, Colburn Laboratory, University of Delaware, Newark, Delaware 19716, USA. Tel +1 (302) 831 3553. Fax +1 (302) 831 4466.

Faraday Discussion 106, Solid State Chemistry: New Opportunities from Computer Simulations

London, UK June 30-July 2
Contact: Dr W C Mackrodt, School of Chemistry, University of St Andrews, Fife, UK KY16 9ST.

July 1997**13th International Meeting: NMR Spectroscopy**

Exeter, UK July 6-11
Contact: RSC†

3rd International Symposium: Supported Reagents and Catalysis in Chemistry

Limerick, Ireland July 8-11
Contact: RSC†

3rd International Conference on Materials Chemistry

Exeter, UK July 21-25
Contact: RSC†

15th International Symposium. Synthesis in Organic Chemistry

Oxford, UK July 22-24
Contact: RSC†

8th International Conference on Bioinorganic Chemistry

Yokohama, Japan July 27-August 1
Contact: Professor Masanobu Hidai, Department of Chemistry and Biotechnology, Faculty of Engineering, University of Tokyo, Hongo 7-3-1, Bunkyo-ku, Tokyo 113, Japan. Tel +81 (3) 3812 2111. Fax +81 (3) 5800 6945.

August 1997**15th International Symposium on Fluorine Chemistry**

Vancouver, Canada August 3-8
Contact: F Aubke or J Shreeve, Department of Chemistry, University of British Columbia, Vancouver, Canada, V6T 1Z1. Tel +1 (604) 822 3817. Fax +1 (604) 822 2847.

XXII International Symposium on Macrocyclic Chemistry

Seoul, Republic of Korea August 3-8
Contact: Professor Si-Joong Kim, XXII ISMC, Department of Chemistry, Korea University, 1 Anam-Dong, Sungbuk-Ku, Seoul 136-701, Republic of Korea. Fax +82 2 921 6900. E-mail sjkim@kcs.korea.ac.kr

43rd International Conference on Analytical Sciences and Spectroscopy

Montreal, Canada August 10-13
Contact: Claude Marsolais, Exhibit Chairman, Perkin Elmer Canada Ltd. Tel +1 800 361 7815. Fax +1 514 737 9726.

International Biometals Symposium

Calgary, Alta., Canada August 10-14
Contact: Margaret-Anne Stroh, The University of Calgary, Conference Management Services, Olympic Volunteer Centre, 1833 Crowchild Trail N.W., Calgary, Alta. T2M 4S7, Canada. Tel +1 (403) 220 6229. Fax +1 (404) 284 4184.

Inorganic Rings International Symposium, IRIS VIII

Loughborough, UK August 10-15
Contact: Professor J D Woollins, Department of Chemistry, Loughborough University, Loughborough, Leicestershire, UK LE11 3TU. Tel +44 (0) 1509 222565. Fax +44 (0) 1509 233163. E-mail j.d.woollins@lut.ac.uk

International Society of Heterocyclic Chemistry, 16th ISHC Congress

Bozeman, USA August 10-15
Contact: Professor T Livinghouse, Department of Chemistry, Montana State University, Bozeman, Montana, 59717, USA. Tel +1 (406) 994 4801. Fax +1 (406) 994 5407. E-mail uchtl@earth.oscs.montana.edu www http://euch6f.chem.emory.edu/bozeman.html

IUPAC Congress

Geneva, Switzerland August 18-22
Contact: IUPAC '97, c/o AKM Congress Service, PO Box 37, CH-1218 Le Grand-Saconnex/GE, Switzerland. Tel +41 22 761 1661. Fax +41 22 761 16 62.

ZMPC '97 International Symposium on Zeolites and Microporous Crystals

Tokyo, Japan August 24-27
Contact: Dr Takahashi Tatsumi, Secretary, ZMPC'97, Engineering Research Institute, Faculty of Engineering, The University of Tokyo, Yayoi, Tokyo 113, Japan.

32nd IUPAC International Conference on Coordination Chemistry

Santiago, Chile August 24-29
Contact: Professor J Costamanga, Faculty of Chemistry and Biology, Universidad de Santiago di Chile, Santiago-2, Chile.

14th International Mass Spectrometry Conference

Tampere, Finland August 24-29
Contact: Mr A Hesso, Chairman, University of Helsinki, Department of Chemistry, Vuorikatu 20, 00100 Helsinki, Finland. Fax +358 (0) 413 691.

4th International Conference on Calixarenes

Parma, Italy August 31-September 4
Contact: Conference Secretary, 4th International Conference on Calixarenes, Dipartimento di Chimica Organica e Industriale, Univerità di Parma, Viale delle Scienze, 43100 Parma, Italy. Tel +39 521 905409. Fax +39 521 905472. E-mail calix@ipruniv.cce.unipr.it WWW http://www.unipr.it/~calix/home.html

XIIth FEICHEM Conference on Organometallic Chemistry

Prague, Czech Republic August 31-September 5
Contact: J Schraml, FEICHEM, Institute of Chemical Process Fundamentals ASCR, 16502 Prague 6-Suchdol, Czech Republic. Tel (+42 2) 24311498. Fax (+42 2) 342073. E-mail FEICHEM@icpf.cas.cz

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3rd European Congress on Catalysis (EuropaCat-3)
Krakow, Poland August 31-September 6
Contact: M Czerwenka, Institute of Catalysis and Surfactant
Chemistry, Polish Academy of Science, ul Niezapominajek,
PL-30239 Krakow, Poland. Tel +48 (12) 252814.
Fax +48 (12) 251923. E-mail ncczerwe@cyf-kr.edu.pl

September 1997

International Phase-Transfer Catalysis Conference
Nagoya, Japan September 25-27
Contact: Professor Takayuki Shioiri, Faculty of Pharmaceutical
Sciences, Nagoya City University, Tanabe-dori, Mizuho-ku,
Nagoya 467, Japan. Tel +81 52 836 3439.
Fax +81 52 834 9309. E-mail shioiri@phar.nagoya-cu.ac.jp

**2nd International Conference on the Chemistry of Alkali and
Alkaline Earth Metals**
Erlangen, Germany September 1997
Contact: Professor P von Ragué Schleyer, Institut für Organische
Chemie der Friedrich Alexander Universität Erlangen-Nürnberg,
Henkestrasse 42, D-91059 Erlangen, Germany.

RSC Autumn Meeting
Aberdeen, Scotland September 1997
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Autumn ACS National Meeting
Las Vegas, USA September 7-11
Contact: American Chemical Society, Meetings, PO Box 18598,
20th St Station, Washington, DC 20036-8598, USA.

4th International Conference on Carbon Dioxide Utilization
Kyoto, Japan September 7-11
Contact: T Inui, Division of Energy and Hydrocarbon Chemistry,
Graduate School of Engineering, Kyoto University, Sakyo-ku,
Kyoto 606-01 Japan. Tel +81 (75) 7535682.
Fax +81 (75) 7717285.

**7th European Conference on the Spectroscopy of Biological
Molecules**
San Lorenzo de El Escorial, Spain September 7-12
Contact: Dr P Carmona, ECSBM'97 Chairman, Instituto de
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Spain. Tel +34 1 5616800. Fax +34 1 5645557.
E-mail pcarmona@pinarl.csic.es

**Faraday Discussion 107, Interaction of Acoustic Waves with
Thin Films and Interfaces**
Leicester, UK September 8-10
Contact: Professor A R Hillman, Department of Chemistry,
University of Leicester, UK LE1 7RH.

30th Colloquium Spectroscopicum Internationale 1997 (CSI)
Melbourne, Australia September 21-26
Contact: The Meeting Planners, 108 Church Street, Hawthorn,
Victoria 3122, Australia.
Tel +61 (3) 981 93700. Fax +61 (3) 981 95978.

3rd World Congress on Oxidation Catalysis
San Diego, USA September 21-26
Contact: A M Gaffney, ARCO Chemical Co, 3801 W Chester Pike,
Newton Square, PA 19073-2387, USA. Tel +1 (610) 3592771.
Fax +1 (610) 3592778. E-mail cvxamg@arco.com

October 1997

7th International Symposium on Catalyst Deactivation
Cancun, Mexico October 5-8
Contact: G A Fuentes, Area de Ingenieria Quimica, University A
Metropolitana-Iztapalapa, AP 55-534, 09340 Mexico, DF Mexico.
Fax +52 (5) 7244900. E-mail gfuentes@xanum.uam.mx or C H
Bartolomew, Chemical Engineering Department, Brigham Young
University, 350 CB, Provo, UT 84602, USA.
Fax +1 (801) 3787799. E-mail bartc@et.byu.edu

November 1997

**7th International Kyoto Conference on New Aspects of Organic
Chemistry**
Kyoto, Japan November 10-14
Contact: Professor Shinji Murai, Department of Applied Chemistry,
Faculty of Engineering, Osaka University, Suita, Osaka 565, Japan.
Tel +81 6 879 7397. Fax +71 6 879 7396.
E-mail ikcoc@chem.eng.osaka-u.ac.jp

5th Chemical Congress of North America
Cancun, Mexico November 11-15
Contact: C Pruitt, Conference Manager, American Chemical
Society, 1155 Sixteenth Street, N.W. Washington, D.C. 20036,
USA. Tel +1 202 872 4397. Fax +1 202 872 6128.
E-mail cpp91@acs.org

March 1998

Spring ACS Meeting
Dallas, USA March 29-April 2
Contact: ACS Meetings, 1155-16th St., N.W., Washington DC
20036-4899, USA. Tel +1 202 872 4396. Fax +1 202 872 6128.
E-mail natlmtgs@acs.org

June 1998

XXIII International Symposium on Macrocyclic Chemistry
Turtle Bay, USA June 7-12
Contact: Jonathan L Sessler, Department of Chemistry and
Biochemistry, The University of Texas, Austin, Texas 78712-1167,
USA. Fax +1 512 471 8696. E-mail sessler@mail.utexas.edu or
Eiichi Kimura, Institute of Pharmaceutical Sciences, Hiroshima
University School of Medicine, Kasumi 1-2-3, Minami-ku,
Hiroshima 734, Japan. Fax +81 82 257 5324.
E-mail ekimura@ve.ipc.hiroshima-u.ac.jp

26th National Medicinal Chemistry Symposium
Richmond, USA June 13-19
Contact: D J Abraham, Virginia Commonwealth University,
Department of Medicinal Chemistry, 410 North 12th St, PO Box
581, Richmond, Va 23298, USA. Tel +1 (804) 828 8483.
Fax +1 (804) 828 7436.

12th International Conference on Organic Synthesis
Venice, Italy June 28-July 2
Contact: Professor C Scolastico, Dip.to di Chimica Organica e
Industriale, Università di Milano, Via G. Venizian 21, I-20133
Milano, Italy.

August 1998

9th International Conference on Pesticide Chemistry
London, UK August 2-7
Contact: RSC†

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E-mail Conferences@rsc.org