Curriculum Vitae di *Alessandro Trovarelli*

Sottosettori ERC primari: *PE5_6, PE5_3 PE4_10*
Eventuali sottosettori ERC secondari: *PE5_2, PE4_17*

• Address
Università di Udine
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• Personal information
Date of birth: January 19th, 1962
Place of Birth: Rome (Italy)
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• EDUCATION

12/12/1986: Doctor Degree in chemistry, Dipartimento di Scienze Chimiche, Facoltà di Scienze Matematiche Fisiche e Naturali, Università di Trieste.

• CURRENT ACADEMIC POSITION

2003 – present: Full Professor of Industrial Chemistry and Chemical Technologies, Dipartimento Politecnico, Università di Udine, Udine, Italy.
Head of the Industrial Chemistry and Catalysis Laboratory

• PREVIOUS POSITIONS

1999-2003 Associate Professor of Industrial Chemistry and Chemical Technologies, Department of Chemical Science and Technology, Università di Udine, Udine, Italy
1998-1999 Associate Professor of Industrial Chemistry and Chemical Technologies, Department of Chemical Engineering, Università di Roma "La Sapienza", Rome, Italy
1993 Sabbatical period as Post doctoral Research Associate, Department of Chemistry , Colorado State University, Ft. Collins CO, (USA)
1992-1993 Sabbatical period as Post doctoral Research Associate, Department of Chemistry, University of Oregon, Eugene OR, (USA)
1991 Sabbatical period as Post doctoral Research Associate, Department of Solid State Chemistry, University of Szeged (HU)
1988-1998 Assistant Professor of Industrial Chemistry and Chemical Technologies, Department of Chemical Science and Technology, Università di Udine, Udine, Italy

RESEARCH ACHIEVEMENTS AND PEER RECOGNITION

Research achievements

For more than 35 years I have been working in the field of materials synthesis for catalytic applications. The main scientific interest has been the development of innovative synthetic methods and new catalyst formulations, including oxide-based materials, solid solutions, metal-doped oxides, perovskites, vanadates and polyoxo compounds, for application in environmental and energy catalysis, with particular emphasis on structural properties and the relationship between material/surface properties and functionality. The following section presents a selection of results relevant to my professional career, with particular emphasis on more recent contributions. I have chosen to start with a selection of early examples that have had a formative influence on my interests and have been instrumental in guiding my scientific career over the years.

1. Trovarelli, A., Dolcetti, G., De Leitenburg, C., Kašpar, J., Finetti, P., Santoni, A. Rh-CeO_2 interaction induced by high-temperature reduction. Characterization and catalytic behaviour in transient and continuous conditions
J. Chem. Soc., Faraday Trans. **1992,** 88 (9), pp. 1311-1319. (**184 cit.** source scopus)
This is one of my first publications on the characterisation and use of ceria in catalysis, which sparked my interest and curiosity in this material. Its synthesis, characterization and applications have characterised a large part of my career at national and international level.

2. Trovarelli, A. Catalytic properties of ceria and CeO_2-Containing materials
Catalysis Reviews - Science and Engineering **1996**, 38 (4), pp. 439-520. (**3445 cit.)**
After a few years of working on ceria and related materials with several highly cited papers, the expertise was strengthened with the publication of this review; the first review on ceria in catalysis and still the most cited article on the subject worldwide.

3. Cavani, F., Comuzzi, C., Dolcetti, G., Etienne, E., Finke, R.G., Selleri, G., Trifirò, F., Trovarelli, A. Oxidative dehydrogenation of isobutane to isobutene: Dawson-type heteropolyoxoanions as stable and selective heterogeneous catalysts
Journal of Catalysis **1996**, 160 (2), pp. 317-321. (**74 cit.)**
This is one of the studies where we used in oxidation catalysis the methods of making polyoxoanions that I learned during postdoctoral period spent at the University of Oregon and Colorado State University (USA).

4. Terribile, D., Trovarelli, A., De Leitenburg, C., Dolcetti, G., Llorca, J. Unusual Oxygen Storage/Redox Behavior of High-Surface-Area Ceria Prepared by a Surfactant-Assisted Route
Chemistry of Materials **1997**, 9(12), pp. 2676-2678. (**105 cit**.)
In this study novel template assisted methods were applied in the preparation of cerium dioxide.

5. Trovarelli, A., Zamar, F., Llorca, J., De Leitenburg, C., Dolcetti, G., Kiss, J.T. Nanophase fluorite-structured CeO_2-ZrO_2 catalysts prepared by high-energy mechanical milling: Analysis of low- temperature redox activity and oxygen storage capacity
Journal of Catalysis **1997**, 169 (2), pp. 490-502. (**436 cit.**)
These last two outputs (4,5) represent an example of two different synthesis approaches that have been used to prepare materials. In 5 mechanical milling was employed for the first time in catalyst preparation. This has been taken up more recently to prepare metal nanoparticles supported on oxides (see 14,16,18, 19 and 20) and is now becoming a common methodology for catalyst preparation and activation.

6. Trovarelli, A., De Leitenburg, C., Boaro, M., Dolcetti, G. The utilization of ceria in industrial catalysis
Catalysis Today **1999**, 50 (2), pp. 353-367. (**901 cit**.)
This paper cemented the expertise on ceria opening up new applications and novel synthesis methods developed in cooperation with industry over the following years.

7. Aneggi, E., Llorca, J., Boaro, M., Trovarelli, A. Surface-structure sensitivity of CO oxidation over polycrystalline ceria powders
Journal of Catalysis **2005**, 234 (1), pp. 88-95. (**258 cit**.)
Highlighted the importance of surface plane exposure in catalysis of polycrystalline ceria.

8. Casanova, M., Rocchini, E., Trovarelli, A., Schermanz, K., Begsteiger, I. High-temperature stability of V_2O_5/TiO_2-WO_3-SiO_2 SCR catalysts modified with rare-earths
Journal of Alloys and Compounds **2006**, 408-412, pp. 1108-1112. (**61 cit**.)
Development in collaboration with a company of modified catalysts for the deNOx reaction. This is the first of a series of studies leading to the commercialisation of Auernox® catalysts from Treibacher Industrie AG.

9. Colussi, S., Gayen, A., Camellone, M.F., Boaro, M., Llorca, J., Fabris, S., Trovarelli, A. Nanofaceted Pd-O sites in Pd-Ce surface superstructures: Enhanced activity in catalytic combustion of methane
Angewandte Chemie - International Edition **2009**, 48 (45), pp. 8481-8484. (**275 cit**.)
Novel preparation method for Pd-based combustion catalysts. This is a key paper in our approach to the preparation of Pd containing formulations for catalytic combustion of methane.

10. Kambolis, A., Matralis, H., Trovarelli, A., Papadopoulou, Ch. Ni/CeO_2-ZrO_2 catalysts for the dry reforming of methane
Applied Catalysis A: General **2010**, 377 (1-2), pp. 16-26. (**406 cit**.)
We have synthesized a series of ceria-zirconia catalysts that have been used by a group from Greece to approach dry reforming of methane.

11. Aneggi, E., Wiater, D., De Leitenburg, C., Llorca, J., Trovarelli, A. Shape-dependent activity of ceria in soot combustion
ACS Catalysis **2014**, 4 (1), pp. 172-181. (**411 cit**.)
First study to highlight the role of different surface facets in soot combustion.

12. Yang, C., Yu, X., Heißler, S., Nefedov, A., Colussi, S., Llorca, J., Trovarelli, A., Wang, Y., Wöll, C. Surface Faceting and Reconstruction of Ceria Nanoparticles
Angewandte Chemie - International Edition **2017**, 56 (1), pp. 375-379. (**226 cit**.)
First approach to use probe molecules to study surface and facet dynamics in nanoshaped ceria particles.

13. Trovarelli, A., Llorca, J. Ceria Catalysts at Nanoscale: How Do Crystal Shapes Shape Catalysis?
ACS Catalysis **2017**, 7 (7), pp. 4716-4735. (**627 cit**.)
Seminal review on the preparation of different ceria nanoshapes and the role of surface modification in catalysis.

14. Danielis, M., Colussi, S., de Leitenburg, C., Soler, L., Llorca, J., Trovarelli, A. Outstanding Methane Oxidation Performance of Palladium-Embedded Ceria Catalysts Prepared by a One-Step Dry Ball-Milling Method
Angewandte Chemie - International Edition **2018**, 57 (32), pp. 10212-10216. (**136 cit**.)
For the first time use of mechanical approach in the preparation of metal supported catalyst formulations.

15. Casanova, M., Hensgen, L., Sagar, A., Schermanz, K., Trovarelli, A. Use of Vanadates as Oxidation Catalysts Patent WO2018050639A1 (**2018**)
The last in a series of patents in collaboration with industry focusing on the preparation of novel vanadates for SCR and oxidation reactions, which is the basis for the commercialisation of Treibacher Industrie AG's Auernox® catalysts (https://treibacher.com/en/products/auernox-2/).

16. Divins, N.J., Braga, A., Vendrell, X., Serrano, I., Garcia, X., Soler, L., Lucentini, I., Danielis, M., Mussio, A., Colussi, S., Villar- Garcia, I.J., Escudero, C., Trovarelli, A., Llorca, J. Investigation of the evolution of Pd-Pt supported on ceria for dry and wet methane oxidation
Nature communications **2022**, 13 (1), p. 5080. (**37 cit**.)
Study of the evolution of bimetallic catalysts (mechanical synthesis *vs* conventional) under different severe conditions.

17. Orsini, F., Ferrero, D., Santarelli, M., Felli, A., Boaro, M., de Leitenburg, C., Trovarelli, A., Llorca, J., Dimitrakopoulos, G., Ghoniem, A.F. Exsolution-enhanced reverse water gas shift chemical looping activity of $Sr_2FeMo_{0.6}Ni_{0.4}O_{6-d}$ double perovskite
Chemical Engineering Journal **2023**, 475, 146083 (**18 cit**.)
An example of our studies involving synthesis and structural evolution of perovskites for applications in catalysis.

18. Jiménez, J.D., Lustemberg, P. G., Danielis, M., Fernández-Villanueva,E., Hwang, S., Waluyo, I., Hunt, A., Wierzbicki, D., Zhang, J., Qi, L., Trovarelli, A., Rodriguez, J.A., Colussi, S., Ganduglia-Pirovano, M.V. and Senanayake S.D. From Methane to Methanol: Pd-iC-CeO_2 Catalysts Engineered for High Selectivity via Mechanochemical Synthesis
Journal of the American Chemical Society **2024**, 146 25986−25999 (**7 cit**.)
This study follows a joint patent application WO2024079594 with BNL-DOE on direct methane to methanol reaction.

19. Danielis, M., Colussi, S., Divins, N.J., Soler, L., Trovarelli, A., Llorca, J. Mechanochemistry: A Green and Fast Method to Prepare a New Generation of Metal Supported Catalysts
Johnson Matthey Technol. Rev., **2024**, 68 217-231 (**10 cit**.)
Invited review from Johnson Matthey to point out the status of mechanochemistry for preparation of catalysts.

20. Danielis, M., Merkouri, L., Braga, A., Trovarelli, A., Duyar, M. S., Colussi, S. Feasibility of green mechanochemical synthesis for dual function material preparation
Journal of CO_2 utilization **2024**, 86 102895 (**7 cit**.)
First use of mechanochemistry to prepare materials for simultaneous CO_2 capture and valorization.

Bibliometric indicators:
Scopus H-index=62, n. of citations > 18800; ISI H-index=62, n. of citations > 17600; Google Scholar H-index=71, n. of citations > 26000. Included in the list of top scientists from the study of Plos Biology (Elsevier-Stanford) ranking in position 5÷12 (single year) and 9÷12 (entire career) among Italian scientists for chemistry in the period 2019-2023. https://elsevier.digitalcommonsdata.com/datasets/btchxktzyw/7

		2019	2020	2021	2022	2023
Rank - entire career	Global: chemistry	508	497	491	485	499
	Italian scientists: chemistry	9	10	11	10	12
Rank - single year	Global: chemistry	256	302	330	499	483
	Italian scientists: chemistry	5	7	7	12	11

Peer recognitions

2022 Mario Giacomo Levi Gold Medal Award from the Division of Industrial Chemistry of the Italian Chemical Society for the innovative activity in industrial chemistry. This award recognizes the many years of collaboration with Treibacher Industrie AG for the development of SCR catalysts commercialized under the Auernox® brand as well as catalysts derived from vanadates and perovskites.
2017-2024 Included in the list of top scientists from the study of Plos Biology (Elsevier Stanford)
2015 University research program award (URP award) from Ford Motor Company. This award is given by Ford "*to some of the world's brightest university professors and students to explore a wide range of new ideas and technologies that could benefit future Ford vehicle development*". It consists of a cheque of 150000 US$. This was given to my group to explore mechanical methods for catalyst preparation.

2014: Chairman of the workshop Fundamentals and applications of cerium dioxide in catalysis, Udine, Italy (100 participants).
2012: Chairman of 8th International Conference on f-Elements, Udine, Italy (350 participants).
2005-2025: Member of the board of several major conferences (2nd International Symposium on Catalytic Removal of Soot Particles, Krakow, September 16-19, 2025; 13th International Conference on Environmental Catalysis (ICEC 2025); GIC-EFCATS 2025 Winter School, L'Aquila, Italy; 4th Conference on Fundamentals and applications of cerium dioxide in catalysis Portorose – Slovenia; 1st International Symposium on Catalytic Removal of Soot Particles, Shenyang, September 3-6, 2021; 12th International Conference on H2 production; 3rd Conference on Fundamentals and applications of cerium dioxide in catalysis Barcelona- Spain; 10th International Conference on f elements- Lausanne Switzerland; Europacat 2017- Florence Italy; International Conference on Rare Earths Development and Application 2016 Lanzhou, China; International Conference on Rare Earths 2013 Ganzhou, China; VI and VII International Workshop on Catalytic Combustion (IWCC).

2016: Guest Editor, Appl. Catalysis B: Environmental, vol. 197, Forty years of catalysis by ceria: a success story
2015: Guest Editor, Catal. Today, vol. 253, Fundamentals and applications of cerium dioxide in catalysis
2003: Guest Editor, Catal. Today, vol. 77, 6th Italian Seminar on Catalysis: Fundamentals and applications to environmental problems
1999: Guest Editor, Catal. Today, vol. 50(2), Recent Progress in catalysis by Ceria and Related Systems,
2002: Editor of the first book devoted to the chemistry and catalysis of Ceria: Catalytic properties of Ceria and CeO_2 containing materials, published by Imperial College Press.
2012 – 2024 Member of Editorial Board of Applied Catalysis B: Environmental (Elsevier)
2007 – present Member of Editorial Board of Journal of Rare Earths (Elsevier)

Expert reviewer for top interdisciplinary journals (Science, Nature, Nature Materials, Nature Catalysis, Nature Communications, Angewandte Chemie, Journal of American Chemical Society….)

Selected invited lectures at meetings: MCE 2015 Meeting, Giessen, Germany, July 2015; ACS Meeting, Boston, USA, August 2015; Sapporo, Japan, Plenary lecture, Rare Earth 2016, June 2016; Peking University, China, Key note lecture, 2ndFACC, July 2016; Bressanone, Italy, Key note lecture, Italian Conference on Catalysis, September 2016; Dechema, Frankfurt, Key note lecture, 27th ATC Industrial Inorganic Chemistry, February 2018; Albarella (RO), Partial PGMS summer school, June 2019; ACS Meeting, San Diego, USA, August 2019; Convegno Nazionale di Chimica Industriale, Catania, November 2022; International workshop on Catalysis for Carbon Neutrality and Energy Transition, Genova, June 2023.
Selected Invited Lectures at companies and institutions: Umicore AG (Hanau-Germany), United Catalysts (Louisville-USA), Ford Motor Company (Derborn-USA), General Motors (Dearborn-USA), WR Grace (Columbia-USA), Johnson Matthey (Reading-UK), Treibacher Industrie AG (Althofen-Austria), TU Wien (Austria), TU Delft (The Netherland), IRCE Lyon (France), ETH Zurich (Switzerland), Paul Scherrer Institute (Villigen, Switzerland), National Institute of Chemistry (Lubiana, Slovenia), Justus Liebig University, Giessen (Germany), Universitad de Cadiz (Cadiz, Spain), Universitat Politecnica de Catalunya UPC (Barcelona, Spain), KIT (Karlsruhe, Germany) and many others.
Major collaborations: J. Llorca, L. Soler, N. Divins (UPC, Barcelona) S. Senanayake, J. Rodriguez (BNL, USA) P. Torelli (CNR, Trieste) M. Duyar (Univ. Surrey, GB) A. Gayen (Jadavpur Univ., India) P. Vernoux, F. Meunier (CNRS, Lyon) J. Perez Ramirez (ETH Zuric, Switzerland) L. Lietti, G.Groppi, L. Castoldi, A. Beretta (Politecnico Milano) C. Wöll (KTU Karlsruhe, Germany), G. Cavataio, R. W. McCabe (Ford Motor Company, Detroit) A. Di Benedetto, G. Landi (Univ. Napoli) A. Sagar, K. Schermanz, C. Artner Wallner (Treibacher Industrie AG, Austria) G. Busca (Univ. Genova) F. Cavani (Univ. Bologna) R. Psaro (CNR Milano) M. Giona (Univ. Roma La Sapienza) R.G. Finke (Colorado State Univ. USA)

ADDITIONAL INFORMATION

Other contributions to the research community

Research management:
2024-present Coordinator of Interdivisional Group of Catalysis (GIC) of the Italian Chemical Society.
2021-2025 Rector's delegate for research, University of Udine
2016-2021 Coordinator of PhD school in Environmental and Energy Engineering Science.
2005-2011 Member of Administrative Board of Sincrotrone Trieste, S.c.p.a.
1990-2025 Mentoring of more than 30 PhD and post doctoral students.

Competitive projects as PI:
2025: REversible Innovative cOnductioN Solid oxide co-electrolysis for CO_2 valorization (RE-IONS), Next generation EU, Ministero dell'ambiente e della sicurezza energetica.

2025-2028 Coordinator and principal investigator of **Hydrogen infrastructure project IMPACT-H2**. A 2.3 M€ project to create and run an infrastructure dedicated to research in the field of fuel decarbonization, green hydrogen production and innovative technologies for hydrogen storage and transport bringing together a group of approximately twenty researchers from University of Udine and Trieste.
2023-2025 GrindRu "An Old Tool for a New, Flexible and Green Procedure toward NH_3 Decomposition Catalysts based on Ruthenium (PRIN 2022) Italian Ministry of Research, National Competitive call, Coordinator and principal Investigator.
I have been responsible as PI or unit leader of several other national and international (EU fundings) competitive projects for a value of around 2.0 M€.

I have been responsible for numerous industrial projects with a total value of around €1.5 millions with the following companies: Treibacher Industrie AG (Althofen-Austria) Umicore AG (Hanau-Germany), WR Grace (Columbia-USA), United Catalysts (Louisville-USA), Ford Motor Company (Derborn-USA), Eni s.p.a. (San Donato, Milano ,Italy), Snamprogetti (San Donato, Milano, Italy), Rhodia Operations, Solvay Collonges (France), Sasol Germany GmbH (Hamburg, Germany), Mel Chemicals (Manchester, UK), Danieli Officine Meccaniche s.p.a. (Buttrio, Italia)

Evaluator of several research proposal for Ministry and national and international agencies and /or Universities.
Evaluator for ERC projects.
Participant to PhD committees in France, Spain, Netherland and Switzerland.
I have been nominated in 2018 evaluator for the PNR project on Energy by the Ministry of Instruction, University and Scientific Research.
I have worked as a consultant for multinational companies in patent disputes relating to catalyst synthesis.

Third mission responsibilities:
2002-2008 Vice President and member of Administrative Board of Science & Tech. Park of Udine. I have contributed to the birth of the technology park and its initial development with the establishment of several companies in technology sectors.
2007-present Founder and partner of LOD s.r.l. Spin off company of the University of Udine (https://www.lodsrl.it/it). The company has been active since 2007, has 9 employees (all with university master or PhD degree) and a turnover in 2024 of more than 1 M€. Its main activities are in the field of odor analysis, dispersion modelling and odor removal technologies.
2023-present: adviser for companies and institutions on the issues of decarbonisation and the use of hydrogen in the energy sector.

In the last years I have been active in several scientific outreach activities, in particular on the benefits and drawbacks of using hydrogen in energy scenarios, on air pollution and on critical raw materials. This activity has been made at Industry associations, seminars, PhD workshops and high schools.