Curriculum Vitae of Alberto Cuoci

Personal Data

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Short bio

I obtained my MSc in **Chemical Engineering from Politecnico di Milano** in 2004. Following that, I pursued a PhD at the same university in collaboration with the University of Utah, where I spent one year as a Visiting Student. My PhD thesis was honored with the **ENI Award 2009 "Debut in Research Prize"** supported by ENI, the Italian oil and gas company, with the objective of promoting the careers of young researchers in the fields of renewable energy and pollution prevention.

In June 2008, I was appointed as an **Assistant Professor at Politecnico di Milano** (Department of Chemistry, Materials, and Chemical Engineering). Later, in 2014, I became an Associate Professor at the same Institution. Additionally, in 2014, I had the opportunity to serve as a **Visiting Professor at Université Libre de Bruxelles (Belgium)**, collaborating with Prof. Parente on the development of a CFD code for turbulent flames based on the EDC (Eddy Dissipation Concept Model). In 2018, I was an **Invited Professor at CentraleSupélec (France)**, working in cooperation with Prof. Fiorina on the development of a virtual chemistry technique for incorporating chemistry in LES of industrial devices. Subsequently, **in 2020, I was awarded the "Humboldt Fellowship" for Experienced Researchers**, conducting research at RWTH Aachen University (Germany) in the research group of Prof. Pitsch.

To date, I have authored or co-authored more than 150 papers published in international journals and have made more than 100 contributions to international conferences on topics encompassing combustion, detailed kinetics, and fluid dynamics of reactive flows.

Current and previous positions

12.2014-present	Associate Professor at Politecnico di Milano, Department of Chemistry, Materials, and Chemical Engineering
6.2008-11.2014	Assistant Professor at Politecnico di Milano, Department of Chemistry, Materials, and Chemical Engineering

Visiting positions

5.2021 - 8.2023	Guest Researcher at RWTH Aachen University (Germany). Collaboration with Prof. H. Pitsch on numerical modeling of soot formation with detailed chemistry in laminar and turbulent flames.
6.2018 – 7.2018	Invited Professor at CentraleSupélec (France). Collaboration with Prof. B. Fiorina on the development of a virtual chemistry technique for including chemistry in LES codes.

2.2014 - 3.2014	Visiting Professor at Université Libre de Bruxelles (Belgium). Collaboration with Prof. A. Parente on the development of a CFD code for turbulent flames based on the EDC model.
10.2006 - 8.2007	Visiting Ph.D. student at University of Utah, hosted by the research group of Prof. P.J. Smith (numerical simulation of turbulent reactive flows, with emphasis on soot formation).

Education

3.2005 - 5.2008	Ph.D. (cum laude) in Chemical Engineering at Politecnico di Milano. Title: Pollutant formation in turbulent reactive flows: interactions between chemistry and turbulence. Advisor: Prof. T. Faravelli.
9.1999 - 10.2004	Master Degree in Chemical Engineering at Politecnico di Milano. Final mark: 100/100 cum laude. Title: Evaporazione e combustione di goccioline di combustibile liquido in condizioni di microgravità. Advisors: Prof. E. Ranzi and Prof. T. Faravelli.

Awards

2020	“Humboldt Fellowship” for Experienced Researchers (2021-2023). Host Institution: RWTH Aachen University (Germany), Prof. Heinz Pitsch
2014	“Chaire Internationale” by Université Libre de Bruxelles (Bureau des Relations Internationales et de la Coopération)
2009	ENI Award 2009 “Debut in Research Prize”
2005-2008	PhD scholarship, Italian Minister of Education (MIUR), Italy
2005	"G. Pastonesi Award", Best M.Sc. Thesis in Chemical Engineering (Politecnico di Milano)

Teaching experience

2022-present	Politecnico di Milano, Lecturer, “Data Science in Chemical Engineering”, Ph.D. School in Industrial Chemistry and Chemical Engineering
2022-present	Politecnico di Milano, Lecturer, “Advanced Transport Phenomena”, M.Sc. in Chemical Engineering
2014-2022	Politecnico di Milano, Lecturer, “Chemical Reaction Engineering”, M.Sc. in Chemical Engineering
2016-2022	Politecnico di Milano, Lecturer, “Computational Fluid Dynamics of Reactive Flows”, M.Sc. in Chemical Engineering
2008-2015	Politecnico di Milano, Lecturer, “Fluid dynamics of fires”, M.Sc. in Chemical Engineering and Safety and Prevention Engineering
2008-2016	Politecnico di Milano, Teaching Assistant, “Fluid mechanics & Fundamentals of Chemical Engineering”, B.Sc. in Chemical Engineering (in Italian)
2007-2011	Politecnico di Milano, Teaching Assistant, “Emissions of pollutants from industrial devices”, M.Sc. in Chemical Engineering (in Italian)
2008-2011	Politecnico di Milano, Teaching Assistant, “Chemical Reaction Engineering”, M.Sc. in Chemical Engineering (in Italian)

Invited lecturer at international Schools

2019	ERCOFTAC Course: Best Practice Guidelines for CFD of Turbulent Combustion, 11-12 December 2019, Bruxelles (Belgium)
2019	Iran First International Combustion School (ICS2019), 24-26 August 2019, Tehran (Iran)

2015 International Combustion Institute Summer School (ICISS) in “Combustion Fundamentals and New Technologies”, The Combustion Institute, 31 May – 5 June 2015, Isola di Procida (Italy)
2013 COST CM0901 Training School on "Modeling Combustion Kinetics", Milano (Italy)
2009 Ph.D. Summer School on "Chemistry and Fluid Dynamics of Combustion", Anacapri (Italy)

Invited talks

2023 “Numerical simulations of reacting flows with detailed kinetic mechanisms in OpenFOAM”, First International OpenFOAM Combustion Workshop, 19-20 June 2023, Chongqing (China)
2023 “Multi-dimensional reactive flows with detailed kinetics in OpenFOAM”, Webinar series “OpenFOAM and Combustion Simulation”, 19 January 2023
2021 “Soot formation and evolution from combustion of isolated droplets in microgravity”, Mechanical Engineering Graduate Seminar, KAUST (Saudi Arabia), 19 April 2021
2015 CatalyticFOAM: first principles multiscale modeling of heterogeneous catalytic reactors in OpenFOAM, Workshop "HPC enabling of OpenFOAM for CFD applications", PRACE, Partnership for advanced computing in Europe, CINECA, Casalecchio di Reno (Bologna), 25 March 2015
2014 Cool flames in microgravity droplet combustion, Université Libre de Bruxelles, 20 March 2014
2014 Numerical simulation of NOx formation in turbulent flames through the Kinetic Post-Processing (KPP) technique, Université Libre de Bruxelles, 5 March 2014
2012 "CatalyticFOAM: heterogeneous catalysis with OpenFOAM", Workshop "HPC enabling of OpenFOAM for CFD applications", PRACE, Partnership for advanced computing in Europe, CINECA, Casalecchio di Reno (Bologna), 26 November 2012
2012 "Efficient Coupling Between Microkinetic Modeling and CFD: Towards a Fully First-Principles Catalytic Chemical Reaction Engineering" (with M. Maestri, Politecnico di Milano), Special Session in Honor of the 2011 Wilhelm Award Winner Dionisios Vlachos, 2012 AIChE Annual Meeting, Pittsburgh (USA), 28th October – 2nd November 2012
2011 “Efficient coupling between microkinetic modeling and CFD: towards a fully first-principles catalytic chemical reaction engineering"" (with M. Maestri, Politecnico di Milano), Lehrstuhl für Theoretische Chemie, Technische Universität München, Garching (Germania), 24 October 2011
2009 "Pollutant formation in turbulent reactive flows: interactions between chemistry and turbulence", Lectio Magistralis, ENI Award 2009, Ideas for a brighter future, Politecnico di Milano, 19 May 2009

Additional activities

2022-present Member of the Board of The Italian Section of the Combustion Institute
2020-present Member of the Board of the PhD Program in Industrial Chemistry and Chemical Engineering at Politecnico di Milano
2020-2022 Member of the Scientific Committee of the Department of Chemistry, Materials, and Chemical Engineering of Politecnico di Milano

Supervision of students

Advisor of the following Ph.D. Students in Industrial Chemistry and Chemical Engineering at Politecnico di Milano:

- 2020-2023: Edoardo Cipriano, Numerical modeling of combustion of heavy fuel oils
- 2018-2021: Giuseppe D’Alessio, Machine learning and mechanism reduction for adaptive chemistry simulations
- 2017-2020: Abd Essamade Saufi, An interface-resolved methodology for the evaporation and combustion modeling of isolated fuel droplets

- 2015-2019: Agnes Livia Bodor, Numerical modeling of soot formation and evolution in laminar flames with detailed kinetics (Marie Skłodowska-Curie PhD Fellowship, CLEAN-Gas EJD)
- 2015-2019: Ali Shamooni Pour Dezfouli, Finite-rate combustion models for Large Eddy Simulation of non-premixed combustion; an "a priori" DNS analysis (Marie Skłodowska-Curie PhD Fellowship, CLEAN-Gas EJD)

Advisor of more than 30 M.Sc. Students in Chemical Engineering and Safety and Prevention Engineering at Politecnico di Milano.

1. Marco Chisacchi, Chemical Vapour Infiltration: numerical modelling of an industrial reactor for the production of carbon disk brakes (2023)
2. Luca Panizza, CFD based study of a Co-firing burner for Sulphur Recovery Unit (2023)
3. Anna Canola, Giorgia Finco, Numerical modeling of H2 addition in micro-perforated burners for domestic condensing boilers (2023)
4. Alessia Costa, Hydrodynamics of aerated stirred tanks using a Population Balance Equation model (2023)
5. Chiara Canciani, Multiphase CFD model for the simulation of multicomponent evaporating droplets with liquid-phase kinetics (2022)
6. Martina Michelle Messuti, Chemical vapor infiltration (CVI) of carbon brake disks: impact of operating conditions on the densification process (2022)
7. Luca Degrandi, A Euler-Euler model for simulations of fluidized bed plastic gasifiers with detailed kinetics (2022)
8. Andrea Gjetja, Maxwell-Stefan diffusion in spherically-symmetric droplets: a semi-implicit implementation (2022)
9. Riccardo Agazzi, Andrea Cittadini, Numerical modeling of laboratory scale and production scale reactors for the chemical vapor infiltration process (2021)
10. Victor Rosa, Design of an electrically heated steam cracking reactor (2021)
11. Mauro Cresseri, Soot precursors and soot dynamics in reactive systems (2021)
12. Francesco Galimberti, Analysis of rapid chemical vapor infiltration process for the production of C/C brake discs (2021)
13. Valerio Fatti, Luca Fois, CFD modeling of gas-solid fluidized beds in OpenFOAM: a comparison between the Eulerian-Eulerian and Eulerian-Lagrangian methods (2021)
14. Francesco Galimberti, Analysis of rapid chemical vapor infiltration process for the production of C/C brake discs (2021)
15. Emanuele Montanari, Thermal degradation of PVC-PET plastic mixtures (2020)
16. Carolyn Elizabeth Montellato, Chemical vapor infiltration (CVI) : numerical modeling of lab-scale and full-scale reactors (2020)
17. Manuel Costantino, Modellazione cinetica dettagliata della degradazione termica del plasmix e dei suoi component (2020)
18. Flora De Menezes, Principal component analysis on soot formation in counterflow diffusion flames (2020)
19. Alessio Bertazzo, Numerical studies of new geometries for chemical vapour infiltration reactors (2019)
20. Tural Mamedov, CFD simulation of aeration and mixing processes in a full-scale oxidation ditch (2019)
21. Lucia Badiali, Experimental and kinetic studies of extinction and autoignition of hydrocarbon fuels, biofuels and their blends in non-premixed and partially premixed flows (2019)
22. Fabio Pizzetti, Massimiliano Turello, Application of detailed kinetic mechanisms to predict combustion properties of linear higher hydrocarbons, bio-fuels and their blends (2018)
23. Matteo Masanti, Analisi fluidodinamica di un reattore catalitico SCR (2018)
24. Francesca Gallone, Federica Zamarian, Numerical modelling of chemical vapour infiltration process for densification of disk brakes (2017)

25. Gianluca Levorati, Evaporazione e combustione di goccioline isolate di combustibili liquidi : estinzioni radiative e fiamme fredde (2016)
26. Abd Essamade Saufi, Soot formation and evolution in a laminar diffusion flame perturbed by a line vortex. A focus on the impact of unsteady effects on complex chemistry (2016)
27. Anthony Sinatra, Fiamme fredde nella combustione di goccioline isolate di combustibili liquidi in condizioni di microgravità (2015)
28. Andrea Mazzucotelli, Loris Torregiani, Modello CFD multiregione per termovalorizzazione di una particella di biomassa lignocellulosica con cinetica dettagliata (2015)
29. Salvatore Raffa, Generazione di griglie di calcolo per letti impaccati di sfere catalitiche (2015)
30. Giancarlo Gentile, Filippo Manelli, An efficient computational framework for the advanced modeling and design of industrial catalytic reactors (2013)
31. Marco Bassani, Modellazione fluidodinamica del combustore Rolls Royce Allison 250 (2012)
32. Mafalda Ciliberti, Manifold generated from local principal component analysis (MG-L-PCA): applications to combustion modeling (2012)
33. Marzio Colombi, Simulazioni RANS di incendi da pool fires in ambienti confinati (2011)
34. Beatrice Carubelli, Simulazioni LES di incendi da pool fires in ambienti confinati (2011)
35. Fabio Benazzato Ortoni, Alessandro Pizzaballa, Analisi fluidodinamica di una fiamma premiscelata turbolenta a getto (2011)

Scientific interests

My primary scientific interests lie in the **numerical modeling of reactive flows with detailed kinetics**, with a specific focus on the formation of pollutants such as NOx, PAHs, and soot in flames and combustion devices. I am the principal author of OpenSMOKE++ (https://www.opensmokepp.polimi.it), a comprehensive framework for numerical simulations of reacting systems with complex chemistry. OpenSMOKE++ has been widely adopted by numerous academic research groups engaged in the development and application of detailed kinetic mechanisms.

Over the past few years, I gradually shifted the focus of my research on the development and implementation of **numerical techniques for accelerating multidimensional CFD simulations** with chemical reactions using machine learning algorithms. More specifically, I am currently exploring the application of Principal Component Analysis (PCA) to dynamic adaptive chemistry and the combination of clustering algorithms and tabulation of detailed chemistry in turbulent flow simulations.

In addition, I am interested in the **multiscale analysis of catalytic processes** and the numerical modeling of heterogeneous catalytic reactors. In collaboration with Prof. Maestri, I have developed the catalyticFOAM framework (http://www.catalyticfoam.polimi.it), a specialized CFD code designed specifically for simulating catalytic reactors using a microkinetic description of surface reactivity.

I regularly collaborate with several research groups from renowned international universities. Notably, I have had longstanding collaborations with Prof. K. Seshadri (UCSD, USA) on counterflow diffusion flames, with Prof. A. Parente (ULB, Belgium) on the application of machine learning algorithms in combustion, and with Prof. T. Avedisian (Cornell University, USA) on evaporation and combustion of isolated fuel droplets.

Academic collaborations

T. Avedisian	Cornell University	Evaporation and combustion of liquid fuel droplets
B. Fiorina	CentraleSupélec, Université Paris-Saclay	Detailed chemistry in Large Eddy Simulations
B. Franzelli	CNRS CentraleSupélec, Université Paris-Saclay	Modeling of soot formation in laminar flames
P. Glarborg	DTU, Denmark	Kinetics of halogenated compounds
M. Ihme	Stanford University, USA	Evaporation and combustion of fuel droplets

M. Maestri	Politecnico di Milano, Italy	Computational Fluid Dynamics of gas-solid heterogenous catalytic reactors
P. Massoli	CNR, Italy	Evaporation and combustion of liquid fuel droplets
P. Medwell	University of Adelaide, Australia	Numerical modeling of MILD combustion
A. Parente	Université Libre de Bruxelles, Belgium	Analysis of turbulent reaction flows via machine learning algorithms
H. Pitsch	RWTH Aachen University	Numerical modeling of turbulent flames
C.F. Qi	University of Science and Technology of China	Numerical modeling of PAHs in laminar coflow flames
A. Sadiki	Technical University of Darmstadt	Numerical simulations of turbulent flames with detailed chemistry
K. Seshadri	University of San Diego, USA	Kinetics of surrogate fuels, counter-flow diffusion flames
H. Wang	Stanford University, USA	Modeling of soot formation in laminar flames

Industrial research projects as Principal Investigator

2022-present	Pietro Fiorentini	Numerical modeling of mechanically agitated bubble reactors for production of biomethane
2022-present	MORE S.r.l.	Detailed kinetics of oxycombustion of hydrogen and methane/hydrogen mixtures
2021-present	Condevo S.p.a.	Numerical modeling of domestic boilers fed with mixtures of methane and hydrogen
2020-present	Casale SA	Development of a numerical platform for modeling turbulent reactive flows, including prediction of NOx
2018-present	Brembo S.p.a.	Numerical modeling of Chemical Vapor Infiltration process and reactors for production of carbon brake discs
2023	Saint Gobain	Numerical modeling of laminar flames with OpenSMOKE++
2021	Tenova	Detailed chemistry of pyrolysis of methane
2020-2022	Ariston S.p.a	Numerical modeling of microforated premixed burners for domestic applications fed with hydrogen
2019	IPLOM	Numerical modeling of leakages of high-viscosity oils from industrial tanks
2018	ENI	Numerical modeling of leakages of high-viscosity oils from industrial tanks
2012-2013	BASF	Computational Fluid Dynamics of heterogeneous catalytic reactors

Research Projects for computational time as Principal Investigator

- CINECA Supercomputing Centre (Bologna, Italy) – Project: POLARYS – Pollutants in Laminar Reacting Systems – (LISA CALL 2014) – Grant: 1 million CPU hours
- CINECA Supercomputing Centre (Bologna, Italy) – Project: SOLARE – Soot formation in Laminar Reacting systems – (ISCRA C CALL 2016) – Grant: 1 million CPU hours
- CINECA Supercomputing Centre (Bologna, Italy) – Project: TLowTech – Turbulence and Low-Temperature Chemistry – (ISCRA B CALL 2017) – Grant: 1 million CPU hours

Bibliometric indices

Scopus	151 papers, 7274 citations, h-index=46

	151 papers, 5878 citations, h-index=40 (self-citations excluded)
Web of Science	133 papers, 6097 citations, h-index=43
Google Scholar	168 papers, 10279 citations, h-index=52

Selected publications

1. **Cuoci, A.,** Frassoldati, A., Faravelli, T., Ranzi, E., OpenSMOKE++: An object-oriented framework for the numerical modeling of reactive systems with detailed kinetic mechanisms (2015) Computer Physics Communications, 192, pp. 237-264, DOI: 10.1016/j.cpc.2015.02.014
2. Maestri, M., **Cuoci, A.,** Coupling CFD with detailed microkinetic modeling in heterogeneous catalysis (2013) Chemical Engineering Science, 96, pp. 106-117, DOI: 10.1016/j.ces.2013.03.048
3. D'Alessio, G., Parente, A., Stagni, A., **Cuoci, A.,** Adaptive chemistry via pre-partitioning of composition space and mechanism reduction (2020) Combustion and Flame, 211, pp. 68-82, DOI: 10.1016/j.combustflame.2019.09.010
4. Bracconi, M., Maestri, M., **Cuoci, A.,** In situ adaptive tabulation for the CFD simulation of heterogeneous reactors based on operator-splitting algorithm (2017) AIChE Journal, 63 (1), pp. 95-104, DOI: 10.1002/aic.15441
5. **Cuoci, A.,** Frassoldati, A., Faravelli, T., Ranzi, E., A computational tool for the detailed kinetic modeling of laminar flames: Application to C2H4/CH4 coflow flames (2013) Combustion and Flame, 160 (5), pp. 870-886, DOI: 10.1016/j.combustflame.2013.01.011
6. **Cuoci, A.,** Mehl, M., Buzzi-Ferraris, G., Faravelli, T., Manca, D., Ranzi, E., Autoignition and burning rates of fuel droplets under microgravity (2005) Combustion and Flame, 143 (3), pp. 211-226, DOI: 10.1016/j.combustflame.2005.06.003
7. **Cuoci, A.,** Frassoldati, A., Buzzi Ferraris, G., Faravelli, T., Ranzi, E. The ignition, combustion and flame structure of carbon monoxide/hydrogen mixtures. Note 2: Fluid dynamics and kinetic aspects of syngas combustion (2007) International Journal of Hydrogen Energy, 32 (15 SPEC. ISS.), pp. 3486-3500, DOI: 10.1016/j.ijhydene.2007.02.026
8. **Cuoci, A.,** Frassoldati, A., Faravelli, T., Ranzi, E. Numerical modeling of laminar flames with detailed kinetics based on the operator-splitting method (2013) Energy and Fuels, 27 (12), pp. 7730-7753, DOI: 10.1021/ef4016334