

Ruben G. Carbonell

Frank Hawkins Kenan Distinguished Professor of Chemical Engineering
Director, the William R. Kenan, Jr. Institute for Engineering, Technology & Science
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Personal Information

- Born, Havana, Cuba, December 27, 1947
- Naturalized US citizen
- Married to Augustina R. Carbonell
- Sons: Tomás and David, Daughter: Rebecca

Education

- Ph.D., Chemical Engineering, Princeton University, 1973
- M.A., Chemical Engineering, Princeton University, 1971
- B.S., Chemical Engineering, Manhattan College, 1969

Experience

North Carolina State University

- Director, William R. Kenan, Jr. Institute for Engineering, Technology and Science, 1999-Present
- Director, Golden Leaf Biomanufacturing Training and Education Center (BTEC), 2008
- Co-Director, NSF Science and Technology Center for Environmentally Responsible Solvents and Processes (with J. DeSimone), 1999-2008
- Director, Kenan Center for the Utilization of CO₂ in Manufacturing (with J. DeSimone), 1997-2005
- Department Head of Chemical Engineering, 1994 - 1999
- Assistant to the Director, Kenan Institute for Engineering, Technology and Science, 1994-1999
- Director, Hoechst Celanese-Kenan Program, 1993-1997
- Interim Chairman, NCSU Biotechnology Faculty, 1990
- Chairman, Bioprocessing/Bioanalytical Interest Group of the Biotechnology Faculty, 1988-1992
- Full Professor, 1984-Present

Department of Chemical Engineering, University of California, Davis

- Full Professor 1983
- Associate Professor 1980 - 1983
- Chairman of the Faculty, College of Engineering, 1981-1982
- Secretary of the Faculty, College of Engineering 1980-1981

- Graduate Studies Adviser, 1977-1983
- Assistant Professor, 1973 - 1980

Honors and Awards

- Fellow, ACS Industrial and Engineering Chemistry Division, 2008
- Alexander Quarles Holladay Medal for Excellence, NC State University, 2007
- Fellow, American Institute of Chemical Engineers, 2003
- Frank Hawkins Kenan Distinguished Professor, 2002
- Alcoa Outstanding Research Award, College of Engineering, NC State University, 2001.
- Editorial Board, Research Journal of Chemistry and the Environment, 2000 - Present
- 2nd Place, International Coatings Exposition 2000 Annual Meeting Poster Competition, (Federation of Societies for Coating Technology)
- KoSa Professor of Chemical Engineering, 1999-2002
- Alumni Distinguished Graduate Professor, NC State University, 1994
- Merck, Sharpe and Dohme Lecturer, University of Puerto Rico, Mayaguez, 1994.
- Maurice Simpson Technical Editors Award for Excellence in the Field of Contamination Control, Institute of Environmental Sciences, 1992
- Outstanding Teaching Award, NC State University, 1991 [Academy of Outstanding Teachers]
- R.J. Reynolds Award for Excellence in Teaching, Research and Extension, College of Engineering, NC State University, 1990
- NCSU Alumni Association Outstanding Research Award North Carolina State University, 1989
- Hoechst Celanese Chair of Chemical Engineering, NC State University, 1989-1999
- Outstanding Teacher Award, Chemical Engineering Department, UC, Davis, 1974, 1977
- Prutton Medal in Chemical Engineering, Manhattan College, 1969

Professional and Consulting Experience

- National Advisory Board, Institute for Emerging Issues, 2005-Present
- Member of Scholars' Council, UNC Tomorrow Commission, 2007-08
- Advisory Commission, NC Museum of Natural Sciences, Raleigh, NC, 2005-Present
- Board of Directors, Center for Innovation Management Sciences, NC State University, 2004-Present
- Board of Directors, Richard and Marlene Daugherty Centennial Campus Entrepreneurialism Endowment, NC State University, 2003-Present
- Founder and member of Scientific Advisory Board of Ligamar, Inc., Raleigh, NC, 2008-Present

- Founder and member of the Scientific Advisory Board and Board of Directors, Pathogen Removal and Diagnostic Technologies, Inc., Rockville, MD, 2001-Present
- Scientific Advisory Board, Prometic Lifesciences, Inc., Montreal, Canada, 2001-Present
- Scientific Advisory Board, Micell Integrated Systems, Raleigh, NC, 1999-Present
- Tech. Advisory Board, CORPEX Inc., Research Triangle Park, NC
- Sandia National Laboratory, Livermore, California
1993- 2000 (Biosensor development)
- Boron Biologicals Inc., Raleigh, NC
1993 (Bioseparations)
- Hoechst Celanese Corporation, Charlotte, NC
1991-1992 (Bioseparations)
- CENTOCOR, Malvern, PA, 1990 (Bioseparations)
- Sandia National Laboratory, Livermore, California
1980 - 1989 (Transport in multiphase Systems)
- Owens- Corning Fiberglas, Granville, Ohio
1984 - 1986 (Transport in multiphase systems)
- Chevron Research and Development, Richmond, California
1983 - 1985 (Chemical reactor design)
- Lockheed Missiles and Space Co., Inc., Palo Alto, California
1983 - 1985 (Transport phenomena)
- Lawrence Livermore Laboratory, Livermore, California
1978 - 1981 (In-situ oil recovery)
- Aerojet Corporation, Sacramento, California
1977 (Chemical reactor design)

Visiting Professor Appointments

- Department of Chemical Engineering, University of Bologna, Italy
2006 Lectures on bioseparations
2002 Lectures on transport processes in supercritical fluids
1988 Lectures on separation of biological molecules
1987 Lectures on two-phase flow and trickle bed reactors
1985 Lectures on microelectronic circuit fabrication
1983 NATO Visiting Professor
Lectures on transport phenomena in multiphase system
[All above lectures given in Italian]
- Institute of Chemistry and Chemical Technology
Edvard Kardelj University of Ljubljana, Yugoslavia
1983 Research Fellow, Slovenian Research Council
- Department of Chemical Engineering
University of Guanajuato, Mexico
1982 OAS Visiting Professor
Lectures on fluid mechanics [in Spanish]

Current Research Grants

National Science Foundation

- “NSF Science and Technology Center for Environmentally Responsible Solvents and Processes”, 1999-2009, \$36 million (with J. DeSimone)
- NSF “Research Experiences for Teachers” Site, PARTNERS: Partnering Researchers and Educators to Create Problem-based Instruction that Adapts Research in Engineering for Students, 2008-2011, \$499,071 (with V. Brown-Schild)

American Red Cross

- “Ligands from Combinatorial Peptide Libraries for Pathogen Detection and Removal”, 2000-2009, \$2,800,000.

Other Grants at NC State University

National Science Foundation

- “An Environmentally Sustainable Approach to Crude Oil Production and Processing: Compressed Gas Demulsification”, 2001-2005, \$201,000 (with P. K. Kilpatrick)
- “Carbon Dioxide in Nature and Technology: Internships in Public Education”, 2002-2005, \$374,378 (with J. DeSimone)
- “Mechanisms of Cleaning Organic Films from Solid Substrates Using Aqueous and Organic Solvents”, 1997-1999, \$180,007 (with C. Grant)
- "Bifunctional Vesicles for Enhancing ELISAS"
1993-1994, \$50,000 (with P.K. Kilpatrick)
- "Selective Precipitation of Proteins with Ligand-Modified Phospholipids"
1992-1996, \$369,628 (with P.K. Kilpatrick)
- "The Removal of Flux Residues from Printed Wiring Assemblies"
1992-1996, \$272,406 (with C.S. Grant)
- "Quantifying Adsorption of Peptides at Gas-Liquid Interfaces"
1993-1996, \$200,000 (with P.K. Kilpatrick and R. VanBremen)
- "New Techniques for Affinity Precipitation of Proteins"
1989-1991, \$198,000 (with P.K. Kilpatrick)
- "Adsorption of Proteins to Gas-Liquid Interfaces"
1986 – 1988, \$161,376 (with P.K. Kilpatrick)
- "Affinity Separations Using Foam Fractionation"
1986 – 1988, \$153,288 (with P.K. Kilpatrick)
- "Equipment for Affinity Foam Separation and Protein Adsorption Studies", 1987, \$52,067 (with P.K. Kilpatrick)
- "Hydrodynamic Behavior of Trickle Bed Reactors"
Travel Grant, 1985 - 1988 with J. Levec
U.S.-Yugoslav Joint Board on Scientific and Technology Cooperation

Tosoh Biosciences, Inc.

- “Affinity Purification of Antibodies Using Small Peptide Ligands”, 2003-2004, \$125,000.

Kenan Center for the Utilization of CO₂ in Manufacturing

- 17 industrial members, 2 Kenan Institute memberships
1997-Present, \$665,000/year (with J. DeSimone)

Office of Naval Research

- "Investigation and Development of CO₂-based Delivery Technologies for Polymeric Coating Materials", 1997-2001, \$300,000 (with J. DeSimone)
VITEX Corporation
- "Ligands from Combinatorial Peptide Libraries for Virus Detection and Removal", 1998-2001, \$250,000

DuPont Corporation

- "Delivery of Polymeric Coatings for the Protection of Monumental and Civil Infrastructure", 1998-2001, \$150,000 (with J. DeSimone)

Sandia National Laboratories

- "Identification of Peptide Ligands for the Detection of Proteins"
1998-2001, \$220,000

US Environmental Protection Agency

- "SERDP Recycle and Reuse of Industrial Cleaning Rags Using Liquid CO₂ and Surfactant Additives as a Cleaning Agent", 1998-2001, \$230,000 (with J. DeSimone)

Gas Research Institute

- "Flow and Dispersion Studies in Porous Media"
1986 – 1987, \$75,000

North Carolina Biotechnology Center

- "Affinity Purification of Proteins Using Ligands Derived from Peptide Libraries", 1993-1994, \$83,064 (with D. Hammond and G. Baumbach, Miles Inc.)
- "Bifunctional Phospholipid Vesicles for Immunosorbent Assays"
1992-1993, \$151,439 (with P.K. Kilpatrick and S. Tonkonogy)
- "Purification of Biological Molecules by Counteracting Chromatographic Electrophoresis", 1986 – 1987, \$20,000

North Atlantic Treaty Organization

- "Swelling of Polymers Membranes by Solvent Penetration - A Mechanical Analysis", Travel Grant, 1985 - 1987 (with G.C. Sarti)

AKZO Corporate Research America, Inc.

- "Affinity Surfactants for Specific Protein Separations"
1988-1991, \$600,000 (with P.K. Kilpatrick)
- "Fluorescent-Labelled Liposomes for Biosensor Applications"
1989-1991, \$243,000
1991-1992, \$181,530 (with P.K. Kilpatrick)

Semiconductor Research Corporation

- "Cleaning Processes for Silicon Wafers"
1988-1992, \$90,000

Ajinomoto Co., Inc.

- "New Techniques for the Purification of Amino Acids"
1992-1996, \$207,000 plus paid postdoctoral student

Hoechst Celanese Corporation

- "Biological Separations Using Fibrous Materials"
1993-1996, \$161,000
- "Biological Waste Minimization by Recovery of Useful Products"

1992, \$5,000

Bayer Corporation

- “Affinity Purification of Proteins Using Ligands from Peptide Libraries”
1992-1999, \$677,905
- “Chromatographic Enantioseparation Using Ligands Derived from Combinatorial Peptide Libraries”
1996-1997, \$164,000

Center for Process Innovation and Pollution Prevention (NCSU)

- “The Removal of Flux Residues from Printed Wiring Assemblies”
1992-1993, \$36,000 (with C.S. Grant)

William R. Kenan Jr. Institute for Engineering, Technology and Science

- “Treatment of Gliomas with Antibody-Targetted Liposomes”
1994-1995, \$50,000 (with K. Quattrocchi, C. Miller)

Patents

1. *Purification by Affinity Binding to Liposomes*, P.K. Kilpatrick, R.G. Carbonell and J.D. Powers, U.S. Patent No. 4,913,902, issued April 3, 1990, Canadian Patent No. 1,309,804, issued November 3, 1992.
2. *Chromatography Apparatus and Method and Material for Making the Same*, R. G. Carbonell, P.K. Kilpatrick, J.L. Torres and R. Z. Guzman, U.S. Patent No. 5,045,190, issued September 3, 1991
3. *Precipitation of Multivalent Antiligands with Affinity Surfactants*, R.G. Carbonell, P.K. Kilpatrick and R. Guzman, U.S. Patent No. 5,112,770, issued May 12 1992.
4. *Continuation of Precipitation of Multivalent Antiligands with Affinity Surfactants*, R.G. Carbonell, P.K. Kilpatrick and R. Guzman, U.S. Patent No. 5,167,925, issued December 1, 1992.
5. *Immunodiagnostic Assay Using Liposomes Carrying Labels Thereof on Outer Liposome Surface*, Ruben G. Carbonell, Peter K. Kilpatrick, Matthew Jones and Anup Singh, U.S. Patent No. 5,494,803, issued February 27, 1996.
6. *Methods of Treating Wastewater*, LiAng Chen, Ruben G. Carbonell, George A. Sarad, U.S. Patent No. 5,695,647, issued December 9, 1997.
7. *Peptide Ligands for Affinity Purification of Fibrinogen*, Kristine Mondorf, Ruben G. Carbonell, and others from Bayer Corp., US Patent No. 5,783,663, issued July 21, 1998.
8. *Alpha-1 Proteinase Inhibitor Binding Peptides*, George A. Baumbach, John M. Lang, Ruben G. Carbonell and Patrick D. Bastek, US Patent No. 5,985,836, issued November 16, 1999
9. *Spin Coating Method and Apparatus for Liquid Carbon Dioxide Systems*, Joseph M. DeSimone, Ruben G. Carbonell and Erik N. Hoggan, US Patent No. 6,001,418, issued December 14, 1999.
10. *Recombinant Factor VIII Binding Peptides*, LiAng Chen, Joseph A. Buettner, Ruben G. Carbonell, US Patent No. 6,191,256, issued February 20, 2001
11. *Enzyme Catalysis in Carbon Dioxide Fluids*, Joseph M. DeSimone and Ruben G. Carbonell, US 6,211,422, issued in April 2001.

12. *Method and Compositions for Protecting Civil Infrastructures*, Ruben G. Carbonell, Joseph M. DeSimone and Florence E. Henon, US Patent No. 6,127,000, issued October 3, 2000
13. *Method for Meniscus Coating with Liquid Carbon Dioxide*, Joseph M. DeSimone, Ruben G. Carbonell and Brian J. Novick, US Patent No. 6,083,565, issued July 4, 2000.
14. *Methods of Spin Cleaning Substrates Using Carbon Dioxide Liquids*, Joseph M. DeSimone, Ruben G. Carbonell, Brian J. Novick and Jim McClain, US Patent No. 6,235,343, issued June 5, 2001.
15. *Apparatus for Liquid Carbon Dioxide Systems*, Joseph M. DeSimone, Ruben G. Carbonell and Jim McClain, US Patent No. 6,383,289, issued May 7, 2002.
16. *Method for Meniscus Coating with Liquid Carbon Dioxide*, Ruben G. Carbonell, Joseph M. DeSimone and Brian J. Novick, US Patent No. 6,497,921, issued December 24, 2002.
17. *Spin Cleaning Methods*, Joseph M. DeSimone and Ruben G. Carbonell, US Patent No. 6,500,273, issued December 31, 2002.
18. *Apparatus for Meniscus Coating with Liquid Carbon Dioxide*, Ruben G. Carbonell, Brian J. Novick, Joseph M. DeSimone, US Patent No. 6,517,633, issued February 11, 2003
19. *Methods of Demulsifying Emulsions Using Carbon Dioxide*, Nael N. Zaki, Peter K. Kilpatrick and Ruben G. Carbonell, US Patent No. 6,566,410, May 20, 2003.
20. *Method for Meniscus Coating a Substrate with Polymeric Precursor*, Brian Novick, Joseph M. DeSimone and Ruben G. Carbonell, US Patent No. 6,652,920, November 25, 2003
21. *Carbon Dioxide-Soluble Polymers and Swellable Polymers for Carbon Dioxide applications*, Joseph M. DeSimone and Ruben G. Carbonell, US Patent No. 6,747,179, June 8, 2004
22. *Compositions for Protecting Civil Infrastructure*, Ruben G. Carbonell and Joseph M. DeSimone, US Patent No. 6,736,996, May 18, 2004
23. *Prion Binding Materials and Methods of Use*, David J. Hammond, Ruben G. Carbonell, Patrick Gurgel, Viterose Wiltshire and Steven J. Burton, WO 2006/044459 A2 (Pending)
24. *Devices and Methods for Removing Target Agents from a Sample*, Ruben G. Carbonell, WO 2005/123952 A2 (Pending)
25. *Prion Protein Ligands and Methods of Use*, David J. Hammond, Julia Lathrop, Larisa Cervenakova, Ruben G. Carbonell, WO 2004/050851 A3

Professional Society Memberships

American Institute of Chemical Engineers (AIChE), American Chemical Society (ACS), New York Academy of Sciences, American Association for the Advancement of Science (AAAS), Council for Chemical Research (CCR), Sigma Xi, Tau Beta Pi, Phi Kappa Phi

Courses Taught at NC State University

CHE 596 Principles of Bioseparations (Developed Course)
CHE 515 Graduate Level Transport Phenomena I

CHE 516 Graduate Level Transport Phenomena II (Developed Course)
CHE 598S Special Topics in Bioseparations (Developed Course)
CHE 495 Senior Seminar
CHE 311 Transport Processes I (Undergraduate)
CHE 312 Transport Processes II (Undergraduate)

Courses Taught at UC Davis

CHE 150A Fluid Mechanics
CHE 150B Heat Transfer
CHE 298 Transport Processes in Porous Media (Developed Course)
CHE 159 Applied Mathematics for Chemical Engineers (Developed Course)
CHE 155A Unit Operations Laboratory
CHE 253A Graduate Fluid Mechanics
CHE 253C Graduate Mass Transfer
CHE 151 Introduction to Chemical Engineering
CHE 261 Graduate Separations Processes
CHE 256 Graduate Chemical Reactor Design
CHE 298 Advanced Topics in Chemical Engineering Analysis (Developed Course)
CHE 156 Chemical Reactor Design