Curriculum Vita: Veronica Vaida

Department of Chemistry & Biochemistry and Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80309-0215

Educational Background:

Post-Doctoral Xerox Research Fellow,1977-1979

Department of Chemistry, Harvard University

Ph.D. 1977 Department of Chemistry 1973-1977 Yale University

B. S. 1973 Chemistry 1970-1973 Brown University

Universitatea Bucuresti, Bucuresti, Romania 1968-1970

Employment:

CIRES Fellow, University of Colorado since 2000

Professor, Chemistry and Biochemistry, University of Colorado, Boulder since 1990

Associate Professor, Chemistry, University of Colorado, Boulder 1984-1990

Assistant and Associate Professor, Chemistry, Harvard University 1979-1984

Honors and Awards:

The 2021 Chemical Pioneer Award- the American Institute of Chemists.

National Academy of Sciences 2020

ACS Irving Langmuir Award in Chemical Physics 2020

2020 Wilbur Lucius Cross Medal - Yale Graduate School Alumni Association

"Veronica Vaida Festschrift" The Journal of Physical Chemistry A, 2018

American Academy of Arts and Sciences fellow 2012

College Scholar Award, University of Colorado 2011

E. Bright Wilson ACS award in Spectroscopy 2011

Boulder Faculty Assembly Excellence in Research, Scholarly and Creative Work 2011

Sigma Xi Distinguished Lecturer 2007-2008

American Physical Society (APS) fellow since 2004

American Association for the Advancement of Science (AAAS) fellow since 2004

John Simon Guggenheim Memorial Foundation Fellow 2004-2005

Radcliffe Institute for Advanced Study at Harvard Fellow 2004-2005

CU Faculty Fellowship 1997-1998 and 2004-2005

Erskine Fellowship, University of Canterbury, New Zealand 1994

Camille and Henry Dreyfus Teacher Scholar 1984

A. P. Sloan Fellowship 1980

Xerox Postdoctoral Fellow, Harvard University 1977-1979

Professional Activities:

Sloan Foundation Indoor Air Program Adviser (2016)

Membership in professional organizations: ACS, AGU, APS and AAAS. APS

DCP nominating committee 2010

Chair, Department of Chemistry and Biochemistry, University of Colorado 2002-2006

Visiting Scientist NCAR 1997

Coordinator: Romanian Chemical Society - ACS advisory group 1995 NSF-

Hungarian Academy of Sciences Review Committee 1992

NRC Committee on Potential Applications of Concentrated Solar Photons 1990-1991 ACS

Executive Committee of the Division of Physical Chemistry (1991-1993), (2007- 2010),

International Activities Committee (2010-2012)

Advisory Boards: (The Journal of Physical Chemistry 1987-1989, Spectrochimica Acta 1992-2000, International Journal of Photoenergy since 2008, International Journal of Spectroscopy since 2008

NSF Advisory Committee for Chemistry 1986-1988

Current Research Interests:

The aim of the scholarly work in my group is to study sunlight driven chemical reactions of organic species in planetary atmospheres including the contemporary and ancient Earth. To this work, I bring tools of physical chemistry. The work explores the building of complexity with sun-light. Water plays a very important role in atmospheric radiative transfer and therefore in climate, my group investigates the role of water on chemistry in all phases and at interfaces.

I proposed that organic films form on atmospheric aerosols and impart on the system unique morphological, optical and chemical properties. My group has extended these ideas to propose atmospheric aerosols to be effective chemical reactors in the contemporary and prebiotic atmosphere. Life requires the nonenzymatic synthesis of biopolymers with the simultaneous development of membrane- enclosed protocells. Recent experimental studies in our group have found chemical processes at the water-air interface such as would be available on oceans, lakes and atmospheric aerosols, for the nonenzymatic synthesis of peptydes from condensation of amino acids. Photochemical synthesis at the water surface under plausible prebiotic conditions yielded membrane components and the formation of vesicular compartments.

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doi.org/10.1002/poc.4316

211. “Water-Air Interfaces as Environments to Address the Water Paradox in Prebiotic Chemistry: A Physical Chemistry Perspective” Deal A.M., Rapf R.J., Vaida V. *J. Phys. Chem. A* **125**(23), 4929-4942 (2021)

210. “Kinetic Study of Gas-Phase Reactions of Pyruvic Acid with HO_2” Church J. R. , Vaida V., Skodje R. T. *J. Phys. Chem A* **125**(11) 2232-2242 (2021)

209. “The primary photo-dynamics of lactate in aqueous solution: decarboxylation prevents dehydroxylation“ Thogersen, Jan, Vaida Veronica, Bregnhoj Mikkel, Weidener Tobias, Jensen Frank *Physical Chemistry Chemical Physics*, **23**(8) 4555-4568 (2021),
DOI: 10.1039/D0CP05650B

208. “Chemistry and Photochemistry of Pyruvic Acid at the Air-Water Interface” Keaten J. Kappes, Alexandra M. Deal, Malte F. Jespersen, Sandra L. Blair, Jean-Francois Doussin, Mathieu Cazaunau, Edouard Pangui, Brianna N. Hopper, Matthew S. Johnson, Veronica Vaida
J. Phys. Chem. A **125**(4), 1036-1049 (2021)
DOI: 10.1021/acs.jpca.0c09096

207. “Lactic Acid Spectroscopy: Intra and Intermolecular Interactions” Frandsen, Benjamin N., Deal Alexandra M., Lane Joseph R., Vaida Veronica *J. Phys. Chem. A* **125**(1), 281-229 (2021)
DOI: 10.1021/acs.jpca.0c09341(2020)

206. “Conformer-Specific Photolysis of Pyruvic Acid and the effect of Water” Blair, Sandra L., Reed Harris Allison E., Frandsen Benjamin N., Kjaergaard Henrik G., Pangui Eduard., Cazaunau Mathieu, Doussin Jean-Francois, Vaida Veronica *J. Phys. Chem A,* **124(**7), 1240-1252 (2020)
DOI:10.1021/acs.jpca.9b10613

205. “Gas-Phase Reaction Kinetics of Pyruvic Acid with OH Radicals: The Role of Tunneling, Complex Formation and conformational Structure” Church, Jonathon R, Vaida V, Skodje Rex T., *J. Phys. Chem A* **124**(5), 790-800 (2020)
DOI: 10.1021/acs.jpca.9b09638

204. “Chemistry and Photochemistry of Pyruvic Acid Adsorbed on Oxide Surfaces” Alves M. R., Fang Y., Wall K. J., Vaida V., Grassian V.H.J. Phys. Chem A (2019)
DOI:10.1021/acs.jpca.9b06563

203. “Heterogeneous Interactions between Gas-Phase Pyruvic Acid and Hydroxylated Silica Surfaces: A Combined Experimental and Theoretical Study” Fang, Yuan; Lesnicki, Dominika; Wall, Kristin J.; Gaigeot, Marie-Pierre; Sulpitzi, Marialore; Vaida, Veronica; Grassian, Vicki H. *J. Phys. Chem. A* **123**(5), 983-991 (2019) DOI:10.1021/acs.jpca.8b10224

202. “Reactivity of Electronically Excited SO_2 with alkanes” Jay A. Kroll, Benjamin A Frandsen, Rebecca J. Rapf, Henrik J. Kjaergaard, Veronica Vaida *J. Phys. Chem. A* **122**(39), 7782-7789 (2018) DOI: 10.1021/acs.jpca.8b04643

201. “Atmospheric Hydroxyl Radical Source: Reaction of Triplet SO_2 and Water” Jay A. Kroll, Benjamin N. Frandsen, Henrik G. Kjaergaard, Veronica Vaida *J. Phys. Chem. A* **122**(18), 4465-4469 (2018) 10.1021/acs.jpca.8b03524

200. “Environmental Processing of Lipids Driven by Aqueous Photochemistry of α-Keto Acids” Rebecca J. Rapf, Russell J. Perkins, Michael R. Dooley, Jay A. Kroll, Barry K. Carpenter, Veronica Vaida *ACS Cent. Sci.* **4**(5), 624-630 (2018) DOI: 10.102/acscentsci8b00124

199. “Prebiotic phosphorylation enabled by microdroplets” Veronica Vaida *Proceedings of the National Academy of Sciences* **114**(47), 12359-12361 (2017)

198. “Atmospheric Simulation Chamber Studies of the Gas-Phase Photolysis of Pyruvic acid” Reed Harris, Allison Early; Cazaunau, Mathieu; Gratien, Aline; Pangui, Edouard; Doussin, Jean-Francois, Vaida, Veronica *J. Phys. Chem. A* **121**, 8348-8358 (2017) DOI:10.1021/acs.jpca.7b05139

197. “pH Dependence of the Aqueous Photochemistry of α-Keto Acids” Rebecca J. Rapf, Michael R. Dooley, Keaten Kappers, Russell J. Perkins, Veronica Vaida *J. Phys. Chem A* **121**, 8368-8379 (2017) DOI:10.1021/acs.jpca.7b08192

196. “Comment on Reactivity of Ketyl and Acetyl Radicals from Direct Solar Actinic Photolysis of Aqueous Pyruvic Acid” V. Vaida, A.E. Reed Harris, R. J. Rapf, R. J. Perkins, B. K. Carpenter *J. Phys. Chem. A* **121**(41), 8738-8740 (2017) DOI:10.1021/acs.jpca.7b06018

195. “Phenylalanine Increases Membrane Permeability” Russell J. Perkins, Veronica Vaida *J. Am. Chem. Soc*. **139**(41), 14388-14391 (2017) DOI: 10.1021/jacs.7b09219

194. “Ultraviolet Spectroscopy of the Gas Phase Hydration of Methylgloxal” Kroll, J.A., Hansen A.S., Moller K.H., Axson J.L., Kjaergaard H. G., Vaida V. *ACS Earth and Space Chemistry* **1**(6) 345-352 (2017) DOI:10.1021/acsearthspacechem.7b00054

193. “Photochemical synthesis of oligomeric amphiphiles from alkyl oxoacids in aqueous environments” Rebecca J. Rapf, Russell J. Perkins, Haishen Yang, Garret M. Miyake, Barry K. Carpenter, Veronica Vaida *J. Am. Chem. Soc.* **139** (20), 6946-6959 (2017) DOI: 10.1021/jacs.7b01707

192. “Mechanistic description of photochemical oligomer formation from aqueous pyruvic acid” Rebecca J. Rapf, Russell J. Perkins, Barry K. Carpenter, Veronica Vaida *J. Phys. Chem. A* **121**, 4272-4282 (2017) DOI: 10.1021/acs.jpca.7b03310

191. “Multiphase Photochemistry of Pyruvic Acid Under Atmospheric Conditions” Reed Harris, Allison Early; Pajunoja, Aki; Cazaunau, Mathieu; Gratien, Aline; Pangui, Edouard; Monod, Anne; Griffith Elizabeth Campbell; Virtanen, Annele; Doussin, Jean-Francois; Vaida, Veronica

The Journal of Physical Chemistry. A **121** (18) 3327-3339, (2017)
DOI:10.1021/acs.jpca.7b01107

190. "Chemical Equilibria and Kinetics in Aqueous Solution of Zymonic Acid" Russell J. Perkins, Richard K. Shoemaker, Barry K. Carpenter, Veronica Vaida *The Journal of Physical Chemistry A* **120**(51), 10096–10107 (2016)
DOI:10.1021/acs.jpca.6b10526

189. "Gas-Phase Photolysis of Pyruvic Acid: The Effect of Pressure on the Reaction Rates and Products" Allison E. Reed Harris, Jean-Francois Doussin, Barry K. Carpenter, Veronica Vaida *The Journal of Physical Chemistry A* **120**(51), 10123-10133 (2016)
DOI:10.1021/acs.jpca.6b09058

188. "Atmospheric radical chemistry revisited; Sunlight may directly drive previously unknown organic reactions at environmental surface" Vaida, Veronica *Science* **353**(6300), 650-650 (2016)

187. "The Partitioning of Small Aromatic Molecules to Air−Water and Phospholipid Interfaces Mediated by Non-Hydrophobic Interactions" Russell J. Perkins, Alexandra Kukharchuk, Pauline Delcroix, Richard K. Shoemaker, Martina Roeselová, Lukasz Cwiklik, and Veronica Vaida *J. Phys. Chem. B*, **120**, 7408−7422 (2016) DOI: 10.1021/acs.jpcb.6b05084

186. "Gas-phase hydrolysis of triplet SO_2: A possible direct route to atmospheric acid formation" Donaldson, D. James; Kroll, Jay A.; Vaida, Veronica *Scientific Reports* Volume: 6 Article Number: 30000 (2016)

185. "Sunlight as an energetic driver in the synthesis of molecules necessary for life" Rebecca J. Rapf, Veronica Vaida *Physical Chemistry Chemical Physics*, **18**, 20067-20084 (2016) DOI: 10.1039/C6CP00980H

184. "Intramolecular Hydrogen Bonding in Methyl Lactate" Schroder SD., Wallberg, JH, Kroll, JA, Maroun, Z, Vaida, V, Kjaergaard, HG *J. Phys. Chem. A* **119** (37) 9692-9702 (2015) DOI: 10.1021/acs.jpca.5b04812

183. "First Reactions: Ocean sea spray, clouds and climate" V. Vaida *ACS Central Science* 2015 DOI: 10.1021/acscentsci.5b0210

182. "Interaction of L-Phenylalanine with a Phospholipid Monolayer at the Water–Air Interface" Griffith, E. C.; Perkins, R. J.; Telesford, D.-M.; Adams, E. M.; Cwiklik, L.; Allen, H. C.; Roeselová, M.; Vaida, V. *J. Phys. Chem. B* 2015. *J. Phys. Chem. B* **119**, 9038-9048 (2015) DOI: 10.1021/jp508473w

181. "Aqueous phase oligomerization of methyl vinyl ketone by atmospheric radical reactions" Renard Pascal, Reed Harris Allison E., Rapf Rebecca J., Ravier Sylvain, Demelas Carine, Coulomb Bruno, Quivet Etienne, Vaida Veronica, Monod Anne *J. Phys. Chem C* **118**, 29421-29430 (2014)
dx.doi.org/10.1021/jp5065598

180. "Photochemical kinetics of pyruvic acid in aqueous solutions" Reed Harris, Allison E., Ervens, Barbara, Shoemaker, Richard K., Kroll, Jay A., Rapf, Rebecca J., Griffith, Elizabeth C., Monod, Anne, Vaida

Veronica *J. Phys. Chem. A* **118**(37), 8505-8516 (2014) doi: 10.1021/jp502186q

179. "Photoinitiated Synthesis of Self-Assembled Vesicles " Griffith, Elizabeth C., Rapf, Rebecca J., Shoemaker, Richard K., Carpenter, Barry K., Vaida, Veronica, *J. Am. Chem.* Soc. **136**(10), 3784-3787 (2014)
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178. "Emerging Areas in Atmospheric Photochemistry" George, C., D'Anna B., Hermann, H., Weller, C., Vaida, V., Donaldson, D. J., Bartels-Rausch, T., Ammann, M., *Atmospheric and Aerosol Chemistry* Ed. Mcneill, VF; Ariya PA Book Series: *Top Curr Chem* **339**, 1-53 (2014) Springer-Verlag Berlin Heidelberg, DOI: 10.1007/128_2012_393

177. "Red-Light initiated atmospheric reactions of vibrationally excited molecules" Vaida V., Donaldson D. J. *Phys. Chem. Chem. Phys* **16** (3), 827 - 836 (2014)
DOI:10.1039/C3CP53543F

176. "Sunlight-initiated Chemistry of Aqueous Pyruvic Acid:
Building Complexity in the Origin of Life" Elizabeth C. Griffith, Richard K. Shoemaker, Veronica Vaida *Orig Life Evol Biosph* **43**(4-5) 341-352 (2013)
DOI 10.1007/s11084-013-9349-y

175. "Reply to Eugene et al.: Photochemistry of aqueous pyruvic acid"
Griffith, Elizabeth C.; Carpenter, Barry K.; Shoemaker, Richard K.; Vaida, Veronica
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DOI: 10.1073/pnas.13163671100

174. "Intramolecular Interactions in 2-Aminoethanol and 3-Aminopropanol" Thomsen D. L. , Axon J. L., Schroder S. D., Lane J. R., Vaida V., Kjaergaard H. G. *J. Phys. Chem. A* **117**, 10260-10273 (2013)
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173. "Oxidized Aromatic-Aliphatic Mixed Films at the Air-Aqueous Solution Interface" Elizabeth C. Griffith, Teobaldo R. C. Guizado, Andre S. Pimentel, Geoffrey S. Tyndall, Veronica Vaida *J. Phys. Chem* A **117**(43), 22341-22350 (2013)

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171. "Acetic acid formation via the hydration of gas-phase ketene under ambient conditions" Kahan, T. F., Ormond, T. K., Ellison, G. B., Vaida, V. *Chem. Phys. Letts*. **565,** 1-4 (2013) doi: 10.1016/j.cplett.2013.02.030

170. **"**Ionization state of L‐Phenylalanine at the Air−Water Interface" Griffith, E. C. and Vaida, V. *J. Am. Chem. Soc* **135(2),** 710−716. (2013) dx.doi.org/10.1021/ja308089n

169. "Ocean –atmosphere interactions in the emergence of complexity in simple chemical systems" Griffith, E. C., Tuck, A. F., Vaida, V. *Acc. Chem. Res.* 45(12) 2106-2113 (2012)
pubs.acs.org/doi/pdf/10.1021/ar300027q

168. "In situ observation of peptide bond formation at the water-air interface" Griffith, Elizabeth C., Vaida, Veronica *Proc. Natn. Acad. Sci* 109(39) 15697-15701 (2012) www.pnas.org/cgi/doi/10.1073/pnas.1210029109

167. "Hydrophobic Collapse of a Stearic Acid Film by Adsorbed L-Phenylalanine at the Air-Water Interface" Griffith, Elizabeth C., Adams, Ellen, Allen, Heather C., Vaida, Veronica, *J. Phys. Chem. B* 116(27), 7849-7857 (2012) DOI: 10.1021/jp303913e

166. "Cavity-enhanced measurements of hydrogen peroxide absorption cross sections from 353 to 410 nm" Kahan T. F., Washenfelder R. A., Vaida V., Brown S. S. *J. Phys. Chem. A* 116(24) 5941-5947 (2012) doi: 10.1021/jp2104616

165. "Near Infrared photochemistry of pyruvic acid in aqueous solution" Larsen M. C., Vaida V. *J. Phys. Chem. A* 116(24), 5840-5846 (2012) doi:10.1021/jp2087972

164. "Will water act as a photocatalyst for cluster phase chemical reactions? Vibrational overtone-induced dehydration reaction of methanediol" Kramer Z. C., Takahashi K., Vaida V. and Skodje R. T. *J. Chem. Phys.* **136**, 164302 (2012); http://dx.doi.org/10.1063/1.4704767

163. "Absolute ozone absorption cross section in the Huggins Chappuis minimum (350–470 nm) at 296K" Axson J. L., Washenfelder R. A., Kahan T. E., Young C. J., Vaida V., Brown S. S., *Atmos. Chem. Phys.* **11**, 11581-11590 (2011) doi:10.5194/acp-11-11581-2011

162. "Hydration of pyruvic acid to its gemina-diol, 2,2-dihydroxypropanoic acid, in a water-restricted environment" Maron M. K., Takahashi K., Shoemaker R. K., Vaida V. *Chem. Phys. Lett.* **513**, 184-190 (2011) doi:10.1016/j.cplett.2011.07.090

161. "Perspective: Water cluster mediated atmospheric chemistry" Vaida, V., *J. Chem. Phys.* **135**(2) Art. Nr. 020901 (2011) doi: 10.1063/1.3608919

160. "Overtone spectra of 2-Mercaptoethanol and 1,2-Ethanedithiol" Miller B. J., Yekutiel M., Sodergren A. H., Howard D. L. Dunn M. E., Vaida V., Kjaergaard H. G. *J. Phys. Chem. A* **114** (48) 12692-12700 (2010)

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151. “Sunlight initiated photochemistry: excited vibrational states of atmospheric chromophores” V. Vaida, K. J. Feierabend, N. Rontu, K. Takahashi *Int. J. Photoenergy* Article Number 138091 (2008)

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Atmospheric Environment **40** (34): 6606-6614 (2006)

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