

2017

Thomas L. Leland, Jr. Lecture

“Navigating the Chemical Engineering Toolbox:
The Curious Matter of C₁ Chemistry”



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NAE, AAAS, and NAI

Theodore Vermeulen Chair
Chemical Engineering
University of CA, Berkeley

Thursday, 03 30

4:00pm - Lecture by Dr. Iglesia
5:00pm - Reception, Hors D'oeuvres

Herzstein Hall

Sadie R. Smith Auditorium
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for direction.



ABSTRACT

The recurring need for advantaged feedstocks as precursors to chemicals and fuels brings us once more to scientific and engineering matters related to the conversion of molecules that lack any C-C bonds, such as methane, methanol, dimethyl ether, and CO. Such C₁ species, and especially methane, impose thermodynamic and kinetic challenges of significant consequence for the complexity and cost of the required chemical transformations. This lecture seeks to chart a roadmap and to assemble some unifying concepts in order to guide our search for attractive C₁ conversion strategies and, in doing so, to define the boundaries of what is reasonable and practical. These concepts are underpinned by the thermodynamics of the relevant transformations and by the formalism of transition state theory in describing the dynamics of chemical reactions. The paths are shaped by: (i) the inherent thermodynamic hurdles and the impotence of catalysis in surmounting them; (ii) the pre-eminence of process simplicity and inexpensive oxidants over alluring direct conversion schemes; (iii) the conceptual framework of kinetic and thermodynamic protection of intermediate species; (iv) the coupling of reactions with separations and of distinct catalytic functions within kinetic cascades; (v) the prevalence of kinetic bottlenecks in forming the first C-C bond from C₁ molecules; and (vi) the emergence of a C₂ conversion platform, as we overcome (or come to accept) the inherent limits in catalytic C₁ chemistries. The conclusions are sobering, as the magnitude of the formidable challenges so warrants. The roadmap is drawn using our chemical engineering toolbox, which proves essential as we seek the small openings that Nature leaves in matters of C₁ chemistry.

ENRIQUE IGLESIA

Dr. Iglesia is the Theodore Vermeulen Chair in Chemical Engineering at the University of California at Berkeley, a Faculty Senior Scientist at the Lawrence Berkeley National Laboratory, and the Director of the Berkeley Catalysis Laboratory. He received a B.S. from Princeton University (1977) and a Ph.D. from Stanford University (1982). He joined Berkeley in 1993 after twelve years in research and management at the Corporate Research Labs of Exxon. He has served as Editor-in-Chief of Journal of Catalysis (1997–2010); he serves as President of the North American Catalysis Society and as Vice President and President-Elect of the International Association of Catalysis Society. He has been elected to the National Academy of Engineering, the American Academy of Arts and Sciences, and the National Academy of Inventors. He is a Fellow of the American Chemical Society and the American Institute of Chemical Engineers and an Honorary Fellow of the Chinese Chemical Society.