College of Engineering
Department of
Mechanical & Industrial Engineering

# The Sidney E. Fuchs Seminar Series

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Frank H. Walk Design Presentation Room

# Chemical Modes in Premixed Combustion


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Due to high efficiency and low emission levels, lean premixed flames are of considerable interest to future clean combustion systems in transportation and stationary power generation. Due to intrinsic instabilities of this combustion mode, development work will rely heavily on accurate numerical tools and chemistry submodels. While offering the most physical insights, direct numerical simulations (DNS) of turbulent premixed combustion with detailed chemistry result in exorbitant computation times. Thus, suitable reduced-order submodels are required. Current approaches replace detailed kinetics by look-up tables with ad-hoc chosen 'flamelet' parameterizations. As flamelets represent fully established flames, extinction and ignition phenomena pose major challenges. In order to overcome this limitation, refined approaches need to map the interaction of chemistry and transport directly, where a detailed understanding of critical thermo-chemical processes is essential.

Chemical Explosive Mode Analysis (CEMA) is used to illustrate how source terms and reactions associated with state variables drive premixed combustion phenomena that are simulated with detailed chemistry. Based on an eigenanalysis of chemical sources terms, chemical source modes and associated reaction modes are distinguished. The dominant mode amplitude is used to determine whether source terms within the flame structure are promoting or counteracting the dominant chemical source mode. Results show a collapse of characteristics across large databases of lean, premixed flames with varying inlet conditions. These collapses represent self-similar flame structures, where the final flame temperature forms a natural parameter.


* Dr. Ingmar Schoegl is as an Assistant Professor of Mechanical Engineering at Louisiana State University. Prior to joining LSU in August 2009, he received his PhD in Mechanical Engineering from The University of Texas at Austin in 2009, and a Diplom-Ingenieur in Mechatronics from the Johannes Kepler Universität in Linz/Austria in 2000. Before his PhD studies, he gained industrial experience working as a development engineer at AVL, a privately owned company specializing in combustion engine research and development. His research interests include modeling of premixed combustion phenomena, tomographic flame diagnostics, and manufacturing of small-scale combustion devices.