**Combustion Energy Frontier Research Center**

**Combustion in the Nation’s Energy Landscape**

- **Combustion is the Dominant Energy Source**
  - Combustion of fossil fuels accounts for 85% of US energy use.
  - **Need for Petroleum Poses Threat to Economic Prosperity and Security**
    - Petroleum accounts for 43% of fossil fuels used for energy generation.
    - Transportation accounts for 60% of petroleum used.
    - 56% of petroleum is imported.
  - **Combustion is the Major Source of Pollutants and GHGs**
    - Fossil fuel combustion accounts for 95% of US anthropogenic greenhouse gas (GHG) emissions.
    - Transportation accounts for 29% of US GHG emissions.

**Combustion in the Nation’s Energy Future**

- **Advances in combustion technology can stretch the petroleum supply and reduce GHG emissions.**
- **Optimal utilization of alternative synthetic and bio-derived fuels requires advances in combustion science.**
- **Combustion is an interdisciplinary and multi-scale problem, requiring an “atoms to applications” approach.**
- **Our challenge is to develop predictive theories and tools to understand and exploit how molecular structure controls combustion.**
- **A multidisciplinary team united by deliverables of combustion models for: Foundational Fuels, Alcohols, Biodiesels**

**Selected Research Highlights**

- **Production of a coordinated and comprehensive matrix of accurate chemical kinetic database** using quantum chemistry calculations and experimentation employing laser diagnostics and synchrotron light sources.
- **A reaction mechanism describing butanol combustion** was developed for high-fidelity simulations of turbulent flames relevant to engine combustion. Shown on right and far right are experimental and simulated images of such turbulent flames; embedded molecules are the four isomers of butanol.
- **A blending strategy for biofuels developed:** Blending diesel with biodiesel and ethanol reduces soot formation and facilitates liquid fuel gasification by inducing fuel droplet explosion. Flame streaks on right:
  - a) Diesel: bright yellow luminosity indicates profuse soot formation.
  - b) Biodiesel: blue luminosity indicates negligible soot formation.
  - c) 25% Ethanol in diesel: significant reduction in soot luminosity with ethanol blending.
  - d) 25% Ethanol in biodiesel: indiscernible droplet explosion, facilitating liquid fuel gasification.

**Educational Programs**

- **Combustion Energy Research Fellows Program**
  - Offers highly-competitive two-year appointments for joint-institute, high-risk, high-payoff research.
  - Each fellowship is co-sponsored by at least two principal investigators. Synergy assured by conducting research at the respective sites of the sponsoring PIs.
  - Facilitates continuous rejuvenation of research directions.
  - Nurtures the next generation of leaders in combustion science and technology.

**Annual Summer School on Combustion**

The annual Summer School on Combustion, held at Princeton University, offers one-week, intensive, advanced graduate-level foundational courses in theory, experiment and chemistry of combustion. The aim of the Summer School is to empower the participants with a comprehensive, interdisciplinary knowledge base needed to make breakthrough discoveries in combustion energy. The lectures are delivered by world-renowned experts in combustion, and are recorded for free access by the public. The 2011 session, scheduled for June 26th to July 9th, will have over 140 participants representing 56 academic institutions, laboratories and corporations from 25 states.

**Attendees of the 2010 session**

http://www.princeton.edu/cefrc/