**GENERAL INFORMATION**

**Program sponsor:** Princeton Environmental Institute  
**Position number:** E1KOE1  
**Project title:** Investigation of Plasma-Assisted Ammonia Synthesis and Dry Reforming of Methane  
**Organization/research group:** Koel Group  
**Primary location(s) of internship:** Princeton University  
**Note:** If this internship is located in a country with an International SOS risk rating of High or Extreme, final candidates must participate in a travel review process overseen by the Travel Oversight Group (TOG), and obtain safety guidance prior to departure. The University reserves the right to revoke support and funding for travel at any time there has been a significant deterioration in the safety and security conditions surrounding travel arrangements, or in the sector of the country, or countries, where travel is to occur.

**FACULTY SPONSOR(s)/HOST INFORMATION**

**Name(s):** Bruce E. Koel  
**University Department(s):** Department of Chemical and Biological Engineering  
**E-mail:** bkoel@princeton.edu  
**Website:** princeton.edu/cbe/people/faculty/koel/group  
**Phone:** 609-258-4524

**INTERNSHIP/RESEARCH PROJECT INFORMATION**

**Internship/project description:**

This project involves investigating plasma-assisted catalytic reactions that can be used to carry out synthesis of ammonia (N2 + H2 → NH3) or methane dry reforming (CH4 + CO2 → CO + H2) as a new approach for conducting energy intensive reactions under low temperature and low pressure conditions. Currently these thermal catalytic reactions consume tremendous amounts of energy and have high operational costs, e.g. ammonia synthesis is carried out in reactors at 450 C and 300 bar pressure and consumes several percent of the world's total energy use. Utilizing plasma (an ionized gas comprised of electrons, ions, and neutral particles) to vibrationally excite reactant molecules may lower the kinetic barriers to catalytic reactions and enable the reaction to occur at low temperature and using less energy. We have constructed several small plasma reactors in order to explore plasma and process parameters that lead to high conversion and efficiency. Students working on the project will gain experience in plasma science, synthesis and characterization of catalyst materials, operation of a catalytic flow reactor, and the use of a gas chromatograph and mass spectrometer for product detection.

**Student's role and responsibilities:**

The roles and responsibilities assigned to students will depend somewhat on their backgrounds, skills and career goals. Experimental work will involve assisting and carrying out independent work including: i) synthesizing and characterizing catalysts; 3) operating the plasma reactor, controlling gas flow and plasma conditions; and 4) measuring conversion and performance utilizing a gas chromatograph and mass spectrometer to analyze reaction products.
Internship/project learning objectives:
Students participating in this project will be able to operate instrumentation and interpret results from several materials characterization tools, including X-ray diffraction (XRD) and X-ray photoelectron spectroscopy (XPS). In addition, they will learn how to synthesize metal catalysts supported on oxide materials using wet chemistry techniques. Student will also learn how to apply and interpret electronic measurements of the plasma current and voltage to determine power and efficiency.

PROGRAM REQUIREMENTS

Academic background and any course pre-requisites:
Preferred: Junior year completed with major in Engineering discipline, Physics, or Chemistry

Technical skills:
Basic laboratory skills and chemical laboratory proficiency.

Additional training(s):
Safety training

Equipment:
none

Physical demands:
none

Language abilities/competencies (if applicable):

Additional information about the internship/project:
Selected student will need to participate in lab safety training prior to the start of the internship.

INTERNATIONAL TRAVEL REQUIREMENTS (if applicable)

Visa(s) required?  Yes [ ]  No [ ]
Research permit/pass required?  Yes [ ]  No [ ]
Immunizations required?  Yes [ ]  No [ ]

INTERNSHIP/PROJECT SUPERVISOR(S)

Name and title of primary supervisor: Bruce E. Koel
Email: bkoel@princeton.edu  Phone:

Name and title of additional supervisor, if applicable: n/a
E-mail:  Phone:

PROGRAM DATES AND FUNDING INFORMATION

Weekly Stipend: $500  Number of Positions Available: 1
Tentative Start Date (mm/dd/yyyy): 06/10/2019  Number of Weeks: 10
Tentative End Date (mm/dd/yyyy): 08/16/2018  Note: PEI funding is for full-time work, 35 hours per week minimum, and for a period of at least 8 continuous weeks.

Application Deadline: January 11, 2019