

## Online Proceedings

---

---

### SESSION 2P

---

#### CHEMISTRY AND MATERIALS FOR ENERGY

Session Moderator: Daniel Kirschen, Electrical Engineering  
**JHN 022**

3:30 PM to 5:15 PM

\* Note: Titles in order of presentation.

##### Using Cobalt Selenide Clusters as Redox-Active Inorganic Ligands

Andrew Colbert Boggiano, Senior, Chemistry  
Mary Gates Scholar, UW Honors Program  
Mentor: Alexandra Velian, Chemistry

Crucial processes in clean energy research, such as the splitting of water into H<sub>2</sub> and O<sub>2</sub> and the reduction of CO<sub>2</sub>, require multi-electron redox events throughout a catalytic cycle. Noble metals such as iridium and platinum prefer such events, while more abundant and consequently cheaper base metals prefer single-electron events. Redox-active ligands offer the potential of enabling noble metal behavior in base metals by combining a single-electron transformation at both the metal and the ligand to create an overall two-electron process. While redox non-innocent ligands are typically comprised of organic components, cobalt selenide clusters offer an attractive alternative given their wide variety of accessible oxidation states. Here, I present the synthesis of heteroleptic cobalt selenide clusters [*cis*-Co<sub>6</sub>Se<sub>8</sub>(PEt<sub>3</sub>)<sub>4</sub>(RNHP(C<sub>6</sub>H<sub>5</sub>)<sub>2</sub>)<sub>2</sub> Et = ethyl, R = alkyl, aryl] containing ditopic aminophosphine ligands. The cluster was then metallated using copper(II) triflate and the product was fully characterized by multi-nuclear nuclear magnetic resonance, ultraviolet-visible, and infrared spectroscopies. Further analysis was performed using cyclic voltammetry and the solid-state structure has been solved via single-crystal X-ray crystallography. Upon spectroscopic analysis, it appears that copper(II) is reduced to copper(I) by the cluster. This result is encouraging, as using clusters as redox-active ligands would require facile electron transfer between the metal atom and the cluster core.

---

### SESSION 2P

---

#### CHEMISTRY AND MATERIALS FOR ENERGY

Session Moderator: Daniel Kirschen, Electrical Engineering  
**JHN 022**

3:30 PM to 5:15 PM

\* Note: Titles in order of presentation.

##### Chemical Protection of Phosphorene using Lewis Acids

David Patrick (David) Hales, Senior, Physics: Applied  
Physics, Chemistry (ACS Certified)  
Mentor: Alexandra Velian, Chemistry

Black phosphorus, an allotrope of phosphorus with a unique layered structure, can be exfoliated to form a few layer variant called phosphorene. Phosphorene has recently emerged in the field of 2D materials as a promising candidate for use in novel electronic and optical devices. Phosphorene's Achilles' heel, however, is its air-sensitivity. When exposed to air, phosphorene is rapidly oxidized, losing its valuable optoelectronic properties. Herein, we propose Lewis acids such as GaCl<sub>3</sub>, AlCl<sub>3</sub>, and AlBr<sub>3</sub> as effective reagents for protecting phosphorene. This Lewis acid-based strategy has advantages over previous methods because it is reversible and leaves phosphorene optically and electronically accessible. A Lewis acid can act as an electron acceptor for the lone electron pairs on the surface of black phosphorus. By sterically blocking oxygen's access to these lone pairs, ambient degradation in phosphorene is drastically slowed.