

## A New Class of Mesoporous Materials for Applications in Petroleum Refining

**Principal Investigator:** Conrad W. Ingram, Ph. D. (Principal Investigator)  
**Student:** Sitra U. Abubeker and Wren Amos  
**Address:** Department of Chemistry,  
Clark Atlanta University,  
223 James P. Brawley Drive  
Atlanta, GA 30314  
**Phone:** 404-880-6898  
**Fax:** 404-880-6890  
**Email:** [cingram@cau.edu](mailto:cingram@cau.edu)  
**Industrial Collaborator:** Atlanta Chemical Technologies  
**Grant No.:** DE-FG26-00NT40833  
**Performance Period:** September 2000 – August 31, 2003

### Abstract

Lamellar and hexagonal mesostructured aluminophosphates with pore size > 2 nm, were synthesized as potential large surface area petroleum refining/oxidation catalysts. Aluminum hydroxide and phosphoric acid were the inorganic precursors. Cetyltrimethylammonium chloride surfactant was used as structure directing template. Tetramethylammonium hydroxide (TMAOH) was employed as charge compensating and/or mineralizer. Synthesis was conducted with reaction mixtures over a range of molar chemical compositions as follows:  $x\text{Al}_2\text{O}_3:y\text{P}_2\text{O}_5:z\text{C}_{16}\text{TACl}:351\text{H}_2\text{O}$ , where  $x = 0.29-2.34$ ,  $y = 0.12-0.50$ , and  $z = 0.34-1.82$ . Lamellar phase was favored by extremely low Al/P ratios (<0.33), low TMAOH content, high  $\text{C}_{16}\text{TACl}$  concentrations and a high synthesis temperature (110°C). The hexagonal phase was favored by higher Al/P ratios and TMAOH content; pH range between 8-10; low  $\text{C}_{16}\text{TACl}$  concentration and ambient temperature. The hexagonal phase demonstrated highest lattice ordering at Al/P ratios 0.47-1.25, above which increasingly disordered products were observed. Aluminum and phosphorus were observed in tetrahedral coordination in the lamellar phase. Aluminum was observed in both tetrahedral and octahedral coordination in the hexagonal phase. No mesostructured products were observed under TMAOH-free conditions. The influence of synthesis variables on product type and quality will be presented.

**List of Published Journal Articles, Completed Presentations and Students Receiving Support from the Grant**

**Publications and Conference Presentations**

- Research paper entitled: "*Studies on the Synthesis of Ordered Mesoporous Aluminophosphates Using Cetyltrimethylammonium Cations as Structure Directing Agent*", C. W. Ingram, S. Abubeker was presented at the 224 ACS National Meeting, Boston, MA, August 18-22, 2002.
- Research paper entitled *Aluminophosphate Mesoporous Structures from the Hydrolysis and Condensation of Inorganic Precursors*, Sitra Abubekar, Conrad Ingram and Jack Eckles Accepted for presentation at NOBCCHE Scientific Conference, New Orleans, March 20, 2002.
- Research paper entitled "A New Class of Mesoporous Materials for Applications in Petroleum Refining" was presented at the University Coal Research Contractors Review Conference June 4-5 2002, at the Marriott City Center in Pittsburgh, Pennsylvania
- Research paper entitled; *Catalytic and Selective Activity of MeAPO036 the Hydrocracking of Gas Oil* was presented at the 13<sup>th</sup> International Zeolite Conference, Montpellier, France, July 8-13, 2001.
- Research paper entitled "A New Class of Mesoporous Materials for Applications in Petroleum Refining" was presented at the University Coal Research Contractors Review Conference June 5-6, 2001, at the Marriott City Center in Pittsburgh, Pennsylvania

**Names of Students Receiving Support**

Sitra U. Abubeker	Graduated with M.S. (Chemistry), May 2001
Wren Amos	Undergraduate senior (Chemistry Biology)