GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[XX] ORIGINAL [ ] REVISION NO. _____

Project No. G-33-695 R6041-2A0 GTRC/~~GIT~~ DATE 9/ 18/ 86

Project Director: Dr. Lawrence A. Bottomley School/~~Lab~~ Chemistry

Sponsor: DHHS/PHS/NIH/NHLBI

Type Agreement: Grant No. 5 R01 HL33734-02

Award Period: From 9/15/86 To 9/14/87 (Performance) 12/14/87 (Reports)

Sponsor Amount:

	This Change	Total to Date
Estimated:	$	$ 67,270
Funded:	$	$ 67,270

Cost Sharing Amount: $ _____ Cost Sharing No: _____

Title: Electrochemical Studies of Capped Matalloporphyrins

ADMINISTRATIVE DATA

OCA Contact E. Faith Gleason ext. 4820

1) Sponsor Technical Contact:

Dr. George Nemo
Division of Blood Diseases and Resources
NHLBI
Bethesda, MD 20892
(301) 496-1537

2) Sponsor Admin/Contractual Matters:

Susan E. Pucie
Grants Operation Branch
Division of Extramural Affairs
NHLBI
Bethesda, MD 20892
(301) 496-7255

Defense Priority Rating: N/A

Military Security Classification: N/A

(or) Company/Industrial Proprietary: _____

RESTRICTIONS

See Attached NIH Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval — Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with GIT

COMMENTS:

SPONSOR'S I. D. NO. 02.108.001.87.001

COPIES TO:

Project Director	Procurement/GTRI Supply Services	GTRC
Research Administrative Network	Research Security Services	Library
Research Property Management	Reports Coordinator (OCA)	Project File
Accounting	Research Communications (2)	Other Jones

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date December 4, 1987

Project No. G-33-695 School/~~Lab~~ Chem.

Includes Subproject No.(s) N/A

Project Director(s) L. A. Bottomley GTRC / ~~GIT~~

Sponsor DHHS/PHS/NIL/NATL Institutes of Health

Title Electrochemical Studies of Capped Metalloporphyrous

Effective Completion Date: 9/14/87 (Performance) 9/14/87 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [x] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other

ontinues Project No. G-33-617 Continued by Project No. G-33-679

OPIES TO:

oject Director
esearch Administrative Network
esearch Property Management
ccounting
ocurement/GTRI Supply Services
search Security Services
ports Coordinator (OCA) ✓
gal Services

Library
GTRC
Research Communications (2)
Project File
Other Duane Hutchison
Angela DuBose
Russ Embry

RM OCA 69.285

SECTION IV **PROGRESS REPORT SUMMARY**	GRANT NUMBER HL 33734-03	
PRINCIPAL INVESTIGATOR OR PROGRAM DIRECTOR Lawrence A. Bottomley	PERIOD COVERED BY THIS REPORT	
APPLICANT ORGANIZATION Georgia Institute of Technology	FROM 09/15/86	THROUGH 09/14/87

TITLE OF PROJECT *(Repeat title shown in item 1 on first page)*
Electrochemical Studies of Capped Metalloporphyrins

(SEE INSTRUCTIONS)

1. SPECIFIC OBJECTIVES FOR THE UPCOMING YEAR.

a) to complete our electrochemical and spectral studies of the reactions of the first row transition "capped" metalloporphyrins especially the high valent forms of the Fe and Mn derivatives.

b) to continue our efforts to isolate single crystals of six-coordinate Fe(II) "capped" porphyrins suitable for x-ray diffraction studies.

c) to initiate and complete our electrochemical and spectroelectrochemical studies of Ru and Os "capped" porphyrins.

We intend to continue our studies of high valent Mn "capped" metalloporphyrin (see discussion below) and also to explore the reactivity of the Fe and Cr counterparts. Studies of Ru and Os "capped" porphyrins have been postponed until this year because of our excitement over the results obtained with the Mn "capped" porphyrin. Special emphasis during the upcoming year will be placed on growing single crystals suitable for x-ray diffraction studies of the binuclear complexes, the hexacoordinate Fe, Ru and Os complexes with dioxygen or CO as one of the axial ligands. We deem that the structural details of these complexes are essential for the complete description of the influence of the cap on the chemical properties of the porphyrins understudy.

We also intend to develop new methods for the characterization of redox intermediates during the upcoming year. These involve the combined use of FTIR spectrometry and electrochemistry. Two proposals are pending which will permit the purchase of an FTIR spectrometer by the School of Chemistry. If funded, we intend to pioneer the application of FTIR spectroelectrochemistry to the characterization of metalloporphyrin redox chemistry. The use of vibrational spectroscopy should also be useful for characterization of intermediates in the nitrogen atom transfer chemistry described below.

SECTION 1

Form Approved OMB No. 0925-0001

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE

APPLICATION FOR CONTINUATION GRANT

REVIEW GROUP	TYPE	ACTIVITY	GRANT NUMBER (Insert on all pages)
BMT	5	P01	HL33734-02

TOTAL PROJECT PERIOD

From: 09/15/85 Through: 09/14/88

REQUESTED BUDGET PERIOD

From: 09/15/86 Through: 09/14/87

To Be Verified By Applicant. Check Information In Items 1 Through 6. If Incorrect, Furnish Correct Information In Item 13.

1. TITLE

ELECTROCHEMICAL STUDIES OF CAPPED METALLOPORPHYRINS

2a. PRINCIPAL INVESTIGATOR OR PROGRAM DIRECTOR (name and address, street, city, state, zip code)

BOTTOMLEY, LAWRENCE A
GEORGIA INSTITUTE OF TECH
SCHOOL OF CHEMISTRY
ATLANTA, GA 30332

2b. DEPARTMENT, SERVICE, LABORATORY OR EQUIVALENT

SCHOOL OF CHEMISTRY

2c. MAJOR SUBDIVISION

COLL OF SCIS & LIBERAL STUDIES

3. ORGANIZATIONAL COMPONENT TO RECEIVE CREDIT FOR BIOMEDICAL RESEARCH SUPPORT GRANT (see instructions)

20 OTHER

4. APPLICANT ORGANIZATION (name and address, street, city, state, zip code)

GEORGIA TECH RESEARCH INSTITUTE
GEORGIA INST OF TECHNOLOGY
ATLANTA, GA 30332

5. ENTITY IDENTIFICATION NUMBER

1580603146A1

6. TITLE AND ADDRESS OF OFFICIAL IN BUSINESS OFFICE OF APPLICANT ORGANIZATION

CONTRACTING OFFICER
GEORGIA TECH RESEARCH INSTITUTE
ATLANTA, GA 30332

COMPLETE THE FOLLOWING (See Instructions)

7. HUMAN SUBJECTS

☒ NO ☐ YES { ☐ Exemption # _____ OR ☐ Form HHS 596 enclosed

8. RECOMBINANT DNA

☒ NO ☐ YES

9. PERFORMANCE SITES(S) (organizations and addresses)

School of Chemistry
Georgia Institute of Technology
Atlanta, GA 30332-0400

10. DIRECT COSTS REQUESTED FOR BUDGET PERIOD

$ 44,241

11. INVENTIONS (see instructions)

☒ NO ☐ YES { ☐ Previously reported OR ☐ Not previously reported

TELEPHONE INFORMATION

	AREA CODE	TELEPHONE NO. AND EXTENSION
12a. PRINCIPAL INVESTIGATOR OR PROGRAM DIRECTOR (Item 2a)	404	894-4014
12b. NAME OF BUSINESS OFFICIAL (Item 6) R. Dennis Farmer	404	894-4817
12c. NAME AND TITLE OF OFFICIAL SIGNING FOR APPLICANT ORGANIZATION (Item 15) R. Dennis Farmer Contracting Officer	404	894-4817

13. USE THIS SPACE FOR CORRECTIONS TO ITEMS 1 THROUGH 6. INDICATE THE NUMBER(S) WHERE ANSWER(S) APPLY.

14. PRINCIPAL INVESTIGATOR/PROGRAM DIRECTOR ASSURANCE: I agree to accept responsibility for the scientific conduct of the project and to provide the required progress reports if a grant is awarded as a result of this application. Willful provision of false information is a criminal offense (U.S. Code, Title 18, Section 1001).	SIGNATURE OF PERSON NAMED IN 2a. (In ink. "Per" signature not acceptable)	DATE 7/28/86
15. CERTIFICATION AND ACCEPTANCE: I certify that the statements herein are true and complete to the best of my knowledge, and accept the obligation to comply with the Public Health Service terms and conditions if a grant is awarded as the result of this application. A willfully false certification is a criminal offense (U.S. Code, Title 18, Section 1001.)	SIGNATURE OF PERSON NAMED IN 12c. (In ink. "Per" signature not acceptable)	DATE 7/30/86

RETURN COMPLETED APPLICATION TO PHS AS SOON AS POSSIBLE.

1. Goals for the previous year:

The research goals for the first year of the grant were:

a) to complete preliminary studies on the cobalt derivative of the "capped" porphyrin;

b) to complete our investigation of sterically unencumbered chalcocarbonyl iron porphyrins in preparation for studies with the analogous "capped" porphyrin derivatives; and

c) to synthesize Fe, Ru, and Os derivatives of the "capped" porphyrin;

2. Description of studies conducted during first year of the grant.

During the first quarter of this grant year, we focused our efforts on completing preliminary studies on the cobalt "capped" porphyrin (hereafter abbreviated CoCap). Through a combined voltammetric and spectroelectrochemical investigation, we learned several points of interest. Firstly, the potentials for electrooxidation of Co(II)Cap were not those predicted from consideration of the phenyl ring substituent effect alone. This suggested that the presence of the cap causes a significant change in solvation of the porphyrin as compared to other sterically unencumbered porphyrins. Secondly, the kinetics of the heterogeneous electron transfer of both the "capped" and unencumbered homologs were comparable in non-coordinating media. Thirdly, the cap prevented the formation of hexacoordinate Co(III) porphyrin complexes. Fourthly, the oxidation of the Co(II)Cap(nitrogenous base) complexes proceeded reversibly whereas the oxidation of the unencumbered porphyrins did not. In the latter complexes, electron transfer occurred concomitantly with changes in the number of ligands coordinated to the Co center. In the former complex, only outer sphere electron transfer reactions were observed. Although our understanding of the redox reactivity of CoCap is far from complete, we submitted the work for publication. A reprint is included in the appendix of this application.

For the next two quarters, our research efforts were devoted to completing our characterisation of iron porphyrins without steric encumbering groups attached to the porphyrin. Our objectives during this phase of the work were to understand the cis-trans effects operative for the chalcocarbonyl iron complexes and to investigate the possibility of forming novel binuclear iron porphyrin complexes. The porphyrins studied were the thiocarbonyl and selenocarbonyl adducts of 2,3,7,8,12,13,17,18-octaethyl- and 5,10,15,20-tetraphenyl-porphyrins, hereafter abbreviated (OEP)FeCS, (OEP)FeCSe, (TPP)FeCS and (TPP)FeCSe, respectively. The redox reactivity of these compounds was investigated at Pt electrodes in nonaqueous media. All underwent a series of charge transfer reactions with complete retention of the diatomic ligand.

As many as three electrooxidation and two electroreduction processes were observable within the potential limits of the halocarbon solvent/supporting electrolyte system. This reactivity is indeed unique. The isoelectronic (OEP)FeCO and (TPP)FeCO complexes both lose the diatomic concomitantly with charge transfer.

Reaction of (OEP)FeCZ and (TPP)FeCZ (where Z = CS or CSe) with a series of monodentate nitrogenous bases (L), produced exceptionally stable six-coordinate mononuclear complexes. These adducts could be oxidized and reduced without loss of the diatomic axial ligand. The reaction of (OEP)FeCZ and (TPP)FeCZ with a series of exo-bidentate nitrogenous bases (L') also produced exceptionally stable six-coordinate complexes. However, this reaction produced either mononuclear or binuclear complexes in dynamic equilibrium. The equilibrium was readily monitored as each species gave distinctive proton NMR resonances. The predominant species in solution could be controlled by varying both the temperature and the relative concentration of base to porphyrin.

The redox reactivity of (OEP)FeCZ(L') and (TPP)FeCZ(L') mirrored that observed when L' was replaced with L. The redox reactivity of the binuclear complexes was consistent only with two non-interacting metal centers. From this work we learned that the Fe-C bond in the chalcocarbonyl Fe porphyrins is exceptionally stable when compared to the bond strength found in carboxy or carbenoid Fe porphyrins. This bond is not broken in the presence of a large excess of secondary amines or by successive charge transfer reactions. Changes in the basicity of the porphyrin N core modifies the total electron density on the Fe atom, but does not alter the stability of the Fe-C bond. Two separate manuscripts describing our results during this phase of the research have been submitted for publication. Preprints are included in the appendix of this application.

Efforts during the final quarter of the budget year were directed towards preparing gram quantities of the "capped" porphyrin. This is a five step time consuming process with an overall yield of less than 5%. We were successful in preparing 2 grams of the porphyrin and have converted a portion to the Fe, Ru and Os derivatives.

5. Specific objectives for the upcoming year:

The research goals for the second year of the grant are:

a) to investigate, in detail, the electrode reactions of Fe, Ru and Os "capped" porphyrins. Special emphasis will be placed on determining the identities of all species generated at the electrode.

b) to react each of these with a series of nitrogenous bases to form pentacoordinate complexes.

c) to synthesize hexacoordinate Fe, Ru and Os "capped" porphyrin complexes with selected nitrogenous bases as the first axial ligand and either dioxygen, CO, CS or CSe as the second axial ligand coordinated to the central metal ion.