

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT TERMINATION

no action
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OK

Date: 10/9/78

Project Title: Localized Corrosion of Dental Amalgam (05 year)

Project No: E-19-B02

Project Director: Dr. M. Marek

Sponsor: DHEW/PHS

Effective Termination Date: 5/31/78 (05 yr.)

Clearance of Accounting Charges: 5/31/78 (05 yr.)

Grant/Contract Closeout Actions Remaining: None

- ☐ Final Invoice and Closing Documents
- ☐ Final Fiscal Report
- ☐ Final Report of Inventions
- ☐ Govt. Property Inventory & Related Certificate
- ☐ Classified Material Certificate
- ☐ Other _____

Assigned to: Chemical Engineering (School/Laboratory)

COPIES TO:

Project Director
Division Chief (EES)
School/Laboratory Director
Dean/Director-EES
Accounting Office
Procurement Office
Security Coordinator (OCA) ✓
Reports Coordinator (OCA)

Library, Technical Reports Section
Office of Computing Services
Director, Physical Plant
EES Information Office
Project File (OCA)
Project Code (GTRI)
Other _____

E-19-B02

GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332

OFFICE OF
THE
COMPTROLLER

November 14, 1978

National Institutes of Health
Division of Financial Management
Grants Section, FAAB
Westwood Bldg., Room 405
5333 Westbard Avenue
Bethesda, Maryland 20014

Dear Sir or Madam:

Enclosed is the Report of Research Grant Expenditures for
Grant No. 5 R01 DE03601-05 covering the period June 1, 1977 to
May 31, 1978.

If you have questions or require additional information,
please let us know.

Sincerely,

David V. Welch, Manager
Grants & Contracts Acctg.

DVW/BIT/bs

Enclosure

cc: Dr. M. Marek
Dr. G. L. Bridger
Mr. E. E. Renfro
Mr. A. H. Becker ✓
File No. E-19-B02

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NAME AND ADDRESS OF GRANTEE INSTITUTION

TRANSACTION NO.

Georgia Institute of Technology
Atlanta, Georgia 30332

(08)R1DE03601B

INSTITUTIONAL ID NO.

E-19-B02

FROM 6/1/77 TO 5/31/78

PROJECT PERIOD

FROM 6/1/76 TO 5/31/79

☐ CHECK IF FINAL REPORT

Expenditures of DHEW Funds for this Reporting Period

a. Personnel	\$ 14,337.71	h. Alterations and renovations	
b. Consultant services		i. Other Retirement	958.32
c. Equipment	4,067.84		
d. Supplies	4,337.14	j. Total direct costs	24,658.36
e. Travel, domestic	957.35	k. Indirect costs:	
f. Travel, foreign		Rate <u>68</u> % <input checked="" type="checkbox"/> S&W <input type="checkbox"/> TDC	
g. Patient care costs		Base \$ <u>14,337.71</u>	9,749.64
		l. TOTAL	\$ 34,408.00
Expenditures from Prior Periods (previously reported)		30,743.05	
Cumulative Expenditures		65,151.05	
Total Amount Awarded - Cumulatively		69,317.00	
Unexpended Balance (Item 4 less Item 3)		4,165.95	
Unliquidated Obligations		-0-	
Unobligated Balance (Item 5 less Item 6)		4,165.95	
a. Cost Sharing Information - Grantee Contribution This Period		2,856.81	
b. % of Total Project Costs (Item 8a divided by total of Items 1 and 8a)		7.7	
a. Interest/Income (enclose check)		-0-	
b. Other Refundable Income (enclose check)		-0-	

0. Remarks

I hereby certify that this report is true and correct to the best of my knowledge, and that all expenditures reported herein have been made in accordance with appropriate grant policies and for the purposes set forth in the application and award documents.

M. Marek / Associate Professor

David V. Welch, Manager, Grants & Contracts Acctg.

SIGNATURE OF INSTITUTION OFFICER

11/10/78

Date

11/14/78

DATE

GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332

OFFICE OF
THE
COMPTROLLER

May 23, 1980

TERMINATED

National Institutes of Health
Division of Financial Management
Grants Section, FAAB
Westwood Bldg., Room 405
5333 Westbard Avenue
Bethesda, Maryland 20205

Dear Sir or Madam:

Enclosed is the Revised Report of Research Grant Expenditures for Grant No. 5 R01 DE03601-05 covering the period June 1, 1977 to May 31, 1978. The report is revised for a \$ 15.37 purchase reported as an unliquidated obligation on the 04 year Report. It was liquidated during the 05 year project period but inadvertently left off of the report.

If you have questions or require additional information, please let us know.

Sincerely,

David V. Welch, Manager
Grants and Contracts Accounting

DVW/BITS/jb

Enclosure

cc: Dr. M. Marek

Dr. G.W. Poehlein

Mr. E.E. Renfro

Mr. O.H. Rodgers ✓

File No. E-19-B02

REVISED

Department of Health, Education, and Welfare

Grant No.

5 R01 DE03601-05

NAME AND ADDRESS OF GRANTEE INSTITUTION

Georgia Institute of Technology
Atlanta, Georgia

TRANSACTION NO.

(08)R1DE03601 B

INSTITUTIONAL ID NO.

E-19-B02

DATE OF THIS REPORTING PERIOD

FROM 6/1/77 TO 5/31/78
PROJECT PERIOD

FROM 6/1/76 TO 5/31/79

☐ CHECK IF FINAL REPORT

1. Expenditures of DHEW Funds for this Reporting Period

a. Personnel	\$14,337.71	h. Alterations and renovations	
b. Consultant services		i. Other Retirement	\$ 958.32
c. Equipment	\$ 4,067.84		
d. Supplies	* 4,352.51	j. Total direct costs	24,673.73
e. Travel, domestic	957.35	k. Indirect costs:	
f. Travel, foreign		Rate 68 % <input checked="" type="checkbox"/> S&W <input type="checkbox"/> TDC	
g. Patient care costs		Base \$ 14,337.71	9,749.64
		l. TOTAL	\$ 34,423.37

2. Expenditures from Prior Periods (previously reported)

30,743.05

3. Cumulative Expenditures

65,166.42

4. Total Amount Awarded - Cumulatively

69,317.00

5. Unexpended Balance (Item 4 less Item 3)

4,150.58

6. Unliquidated Obligations

-0-

7. Unobligated Balance (Item 5 less Item 6)

4,150.58

8.a. Cost Sharing Information - Grantee Contribution This Period

2,856.81

b. % of Total Project Costs (Item 8a divided by total of Items 1 and 8a)

% 7.7

9.a. Interest/Income (enclose check)

-0-

b. Other Refundable Income (enclose check)

-0-

10. Remarks * Unliquidated Obligation from 04 year paid in 05 year \$ 15.37
 Obligations made and liquidated in 05 year 4,337.14
\$4,352.51

I hereby certify that this report is true and correct to the best of my knowledge, and that all expenditures reported herein have been made in accordance with appropriate grant policies and for the purposes set forth in the application and award documents.

SIGNATURE OF INSTITUTION OFFICER

David V. Welch, Manager, Grants & Contracts Acctg.
404/894/4624

DATE

5/26/80

REPORT OF RESEARCH GRANT
EXPENDITURES

APPLICANT: REPEAT GRANT NUMBER SHOWN ON PAGE 1 →		GRANT NUMBER	
SECTION IV—SUMMARY PROGRESS REPORT		DE 03601-06	
PRINCIPAL INVESTIGATOR OR PROGRAM DIRECTOR (Last, First, Initial)		PERIOD COVERED BY THIS REPORT	
MAREK, Miroslav		FROM	THROUGH
NAME OF ORGANIZATION		06/01/77	05/31/78
Georgia Institute of Technology			
TITLE (Repeat title shown in item 1 on first page)			
EFFECT OF LOCALIZED CORROSION ON DENTAL AMALGAMS			

1. List publications: (a) published and not previously reported; (b) in press. Provide five reprints if not previously submitted.
2. List all additions and deletions in professional personnel and any changes in effort.
3. Progress Report. (See Instructions)

Publications (in press):

M. Marek and T. Okabe: "Corrosion Behavior of Structural Phases in High Copper Dental Amalgam." Accepted for publication in the Journal of Biomedical Materials Research.

C. W. Fairhurst, M. Marek, M. B. Butts, and T. Okabe: "New Information on High Copper Amalgam Corrosion." Accepted for publication in the Journal of Dental Research.

Progress Report

I. OBJECTIVES

The overall objective of the project is to investigate in vitro the mechanism and effects of corrosion in dental amalgam of various compositions and structures.

The goals for the current year have been as follows:

1. To investigate the relationship between corrosion conditions, the composition and structure of the amalgam, and the rate and form of the corrosion attack;
2. To investigate the mechanism of the corrosion attack;
3. To study the corrosion properties of the amalgam phases;
4. To investigate the effect of corrosion on the mechanical properties.

II. STUDIES AND RESULTS

The relationship between corrosion conditions, type of amalgam, and the resulting attack was investigated using the corrosion test procedure developed during the previous year. In this test standard ADA specimens are exposed to 1% NaCl and polarized to a controlled potential, and the current is recorded and integrated over the test period. The effects of temperature, time and potential were examined; the results can be summarized as follows: The test is temperature sensitive, the reaction rate increasing with temperature; the total charge (integrated current = corrosion index) increases with the polarization potential to about +0.05V (SCE) and then drops for conventional amalgam; the drop is not observed for high copper amalgams; the current stabilizes in most cases after about 20 hours. On the basis of the above results the standard test conditions were selected as follows: temperature $37 \pm 0.25^\circ\text{C}$, polarizing potential 0.0 V (SCE), test period 24 hours.

Different types of commercial dental amalgam have shown substantial differences in corrosion test results. High copper amalgams as a group exhibited better corrosion resistance than conventional amalgams, best results being obtained consistently for a

single composition alloy amalgam (Tytin). However, other brands of single composition alloy amalgam showed substantially lower corrosion resistance, which further decreased with the aging of the amalgam. The behavior of dispersed phase (additive) type of high copper amalgam generally improved with aging.

The form of the corrosion attack was examined on specimens exposed in a special crevice cell and on specimens exposed to a 1% NaCl for up to one year, using metallography, electron microprobe analysis, and SEM. In conventional amalgam the γ_2 was attacked whenever crevice conditions occurred and was transformed into a tin oxide; in surface regions tin chloride complex was the additional corrosion product. Morphological changes of the γ_1 phase were also observed as a result of corrosion. In high copper amalgams a complex behavior was observed, which is only partially understood at this time. The copper-tin reaction phase, which forms in both dispersed phase and single composition alloy amalgams, was found to change in the interior of the structure as a result of the corrosion activity on the surface of the amalgam; the result was a depletion of copper in the corrosion affected zone, copper was found to enter the solution as soluble species. At the same time the γ_1 matrix phase was transformed into the β_1 phase, and the dissolved tin reacted with the environment to form tin oxide.

The investigation of the corrosion properties of the amalgam phases was continued for the γ_1 phase. The corrosion behavior was found to be a function of the tin content; at higher tin concentrations an intergranular form of attack was observed. The results indicate a complex relationship between the tin concentration, the rate of the attack, and the $\gamma_1 \rightarrow \beta_1$ phase change.

An extensive test program was initiated to study the effects of corrosion on the mechanical properties of 14 types of commercial dental amalgam in the effort to correlate corrosion behavior with structure and composition. To date two exposures were completed, two months and one year, and a partial analysis of the data. The exposures were made under the conditions of general, crevice and galvanic corrosion. Compressive strength tests after one year showed strength losses due to general corrosion ranging from insignificant for a single composition alloy high copper amalgam (Tytin) to 50% for a conventional lathe cut amalgam. Dispersed phase type amalgams showed good resistance to deterioration, the strength losses averaging 11% for the four brands tested. Different single composition alloy type amalgams showed larger differences in behavior, the losses ranging from insignificant to 30%. The galvanic contact with gold resulted in a further reduction in strength averaging 13%. Specimens have been examined for both surface and interior changes. Growth of β_1 crystals on surfaces of corroded high copper amalgams was observed for the first time, together with the formation of other corrosion products.

A creep testing machine for dental amalgam was designed and built to allow determination of the effects of corrosion on creep. The creep tests will be initiated before the end of the current project period.

III. SIGNIFICANCE

It is generally accepted that corrosion plays a significant role in the deterioration of amalgam restorations. The understanding of the mechanism of

corrosion and of the effects on the structure and properties of dental amalgam will make possible the development of better restorative materials.

IV. RESEARCH GOALS FOR THE COMING YEAR

The following tasks will be performed:

1. Determination of the effects of corrosion on the mechanical properties of various types of dental amalgam.

This is a continuation of the test program initiated in the current year. A six month exposure will be added. Compressive strength and creep will be determined for the 14 types of commercial dental amalgam following the exposure and the results will be compared with those of controls and previous exposures.

2. Determination of the effects of corrosion on the structure of various types of dental amalgam.

Metallographic examination will be completed on the specimens exposed for two month and one year, and on the six month specimens. Phases in the structures of both controls and corroded specimens will be identified using optical and scanning electron microscopy and electron microprobe analysis.

3. Determination of the corrosion behavior of the various types of dental amalgam

The 14 types of dental amalgam will be examined by anodic polarization tests, potential-time tests, and using the integrated current test procedure developed in this program. This will allow an analysis of the correlation between composition, structure, electrochemical properties, and the effects on the mechanical properties.

4. Investigation of the mechanism of corrosion of dental amalgam.

The study of the electrochemical reactions in localized corrosion cells will be continued. This includes determination of all relevant parameters such as potentials, currents and solution chemistry in special cells. The current analytical procedures will be improved to achieve higher sensitivity in detecting solution chemistry changes.

The undersigned agrees to accept responsibility for the scientific and technical conduct of the project and for provision of required progress reports if a grant is awarded as the result of this application.

March 24, 1978

Date

Principal Investigator or
Program Director