16:54:13 OCA PAD INITIATION - PROJECT HEADER INFORMATION 08/10/90

Active

Project #: E-18-611 Cost share #: Rev #: 0
Center # : 10/24-6-R6363-5A0 Center shr #: OCA file #:
Work type : RES
Contract#: 5 R01 DE07754-05 Mod #: Document : GRANT
Prime #: Contract entity: GTRC

Subprojects ? : N
Main project #:

Project unit: MECH ENGR Unit code: 02.010.126
Project director(s):
MAREK M I MAT ENGR (404)894-2380

Sponsor/division names: DHHS/PHS/NIH / NATL INSTITUTES OF HEALTH
Sponsor/division codes: 108 / 001

Award period: 900801 to 910731 (performance) 911031 (reports)

Sponsor amount	New this change	Total to date
Contract value	141,155.00	141,155.00
Funded	141,155.00	141,155.00
Cost sharing amount		0.00

Does subcontracting plan apply ?: N

Title: DISSOLUTION OF MERCURY FROM DENTAL AMALGAMS

PROJECT ADMINISTRATION DATA

OCA contact: Kathleen R. Ehlinger 894-4820

Sponsor technical contact

DR. JOYCE REESE
(301)496-7884

RESTORATIVE MATERIALS RESEARCH
NATL INSTITUTE OF DENTAL REARCH
BETHESDA, MD 20892

Sponsor issuing office

MR. MARTIN RUBINSTEIN
(301)496-7437

EXTRAMURAL PROGRAMS, NIH/NIDR
NATL INSTITUTE OF DENTAL RESEARCH
BETHESDA, MD. 20892

Security class (U,C,S,TS) : U ONR resident rep. is ACO (Y/N): N
Defense priority rating : N/A NIH supplemental sheet
Equipment title vests with: Sponsor GIT X

Administrative comments -
INITIATION OF PROJECT. YEAR 5 OF 6 YEAR PROJECT. CONTINUATION OF E-18-670.

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT

Closeout Notice Date 09/11/91

Project No. E-18-611 Center No. 10/24-6-R6363-5A0

Project Director MAREK M I School/Lab MAT ENGR

Sponsor DHHS/PHS/NIH/NATL INSTITUTES OF HEALTH

Contract/Grant No. 5 R01 DE07754-05 Contract Entity GTRC

Prime Contract No.

Title DISSOLUTION OF MERCURY FROM DENTAL AMALGAMS

Effective Completion Date 910731 (Performance) 911031 (Reports)

Closeout Actions Required:	Y/N	Date Submitted
Final Invoice or Copy of Final Invoice	N	
Final Report of Inventions and/or Subcontracts	N	
Government Property Inventory & Related Certificate	N	
Classified Material Certificate	N	
Release and Assignment	N	
Other	N	

CommentsCONTINUED BY E-18-634

Subproject Under Main Project No.

Continues Project No. E-18-670

Distribution Required:

Project Director	Y
Administrative Network Representative	Y
GTRI Accounting/Grants and Contracts	Y
Procurement/Supply Services	Y
Research Property Menagment	Y
Research Security Services	N
Reports Coordinator (OCA)	N
GTRC	Y
Project File	Y
Other	N
	N

SECTION IV **PROGRESS REPORT SUMMARY**	GRANT NUMBER DE07754-06	
PRINCIPAL INVESTIGATOR OR PROGRAM DIRECTOR Marek, Miroslav I.	PERIOD COVERED BY THIS REPORT FROM	THROUGH
APPLICANT ORGANIZATION Georgia Tech Research Corporation	08/01/90	07/31/91

TITLE OF PROJECT *(Repeat title shown in item 1 on first page)*
Dissolution of Mercury from Dental Amalgams

(SEE INSTRUCTIONS)

1. SUMMARY OF PLANS FOR THE NEXT YEAR OF SUPPORT

Objectives: The long-range goal of the program is an understanding of the process of release of mercury from dental amalgam restorations, and finding ways to minimize the amounts released (No change).

Specific Aims

1. To determine the kinetics of repassivation of dental amalgam (Task 4 of the original proposal)

2. To determine the kinetics of dissolved mercury oxidation in the solution as a function of the solution chemistry (new Task)

3. To design the experimental setup for the study of mercury dissolution evaporation from a bare amalgam surface (Part of Task 3 of the original proposal).

The experimental design for Specific Aim #1 will include both mechanical and electrochemical depassivation of the amalgam surface; the kinetics of repassivation will be measured, using a potentiostat and a fast oscilloscope, to determine the repassivation constant as a function of temperature, pH, and solution chemistry. The kinetics of dissolved mercury oxidation (Specific Aim #2) will be studied in a special cell in which mercury vapor will be carried in a stream of a gas mixture through solutions of various chemistry. The mercury vapor concentration in the outlet gas stream will be measured, using Atomic Absorption Spectrophotometry. The rate of oxidation in the solution will be determined from the difference between the inlet and outlet mercury concentrations. It will be examined as a function of the oxidation power of the solution. Specific Aim #3 will involve the design and construction of a special cell for measurement of mercury dissolution and evaporation under abrasion, simulating the abrasion in the oral cavity. Preliminary data will be obtained.

2. STUDIES PERFORMED DURING THE CURRENT BUDGET YEAR

The studies performed followed the plan of Task 2 of the proposed program, *i.e.*, " A Study of Dissolution/Evaporation in the Presence of a Film of Liquid on the Amalgam Surface." These tests simulated the mercury release from a dental amalgam restoration under rest conditions, *i.e.*, without abrasion of the surface. The tests were performed as a function of the material, temperature, and pH.

A special cell was built, in which an amalgam specimen, covered with a layer of synthetic saliva, was exposed to a stream of humid air at a constant flow rate of 160 mL/min. The air stream passed through the cell containing the specimen and into a liquid trap, filled with a potassium permanganate solution, in which the mercury vapor, released from the specimen, was oxidized and dissolved. After a period of

exposure both the trap liquid and the liquid on the amalgam surface were analyzed for mercury by Atomic Absorption Spectrophotometry.

The basic series of tests (temperature 37°C, pH 6.8, liquid layer thickness 0.2 mm) was performed using the following materials: gamma-1 phase without tin (Ag-Hg); Gamma-1 phase, 1% Sn (Ag-Hg-Sn); high copper, single alloy composition dental amalgam (Tytin); high-copper, admixed dental amalgam (Dispersalloy); very-high copper, spherical dental amalgam (Sybralloy); low-copper dental amalgam (Velvalloy). The effect of pH was examined at 37°C for Gamma-1, Gamma-1(+Sn), and Tytin for pH values 4.5, 5.5, and 7.5. The tests of the effect of temperature are in progress at temperatures of 25°C, 45°C, and 55°C.

The basic series of tests (37°C, pH 6.8, 0.2 mm of liquid) showed total mercury release at a mean rate of 1.6 ug/cm^2 for Gamma-1 (0% Sn), 0.15 ug/cm^2 for Gamma-1 (1% Sn), 0.02 ug/cm^2 for Tytin, 0.02 ug/cm^2 for Dispersalloy, and 0.04 ug/cm^2 for Sybralloy. The mercury concentration in the liquid was proportional to the total mercury release. There was no statistically significant difference in the release rate for the pH values examined (pH 4.5 to 7.5). The initial results of the effect of temperature show the release rate increasing substantially with temperature.

The results to date show that there is a measurable, but small rate of release of mercury from dental amalgam under rest conditions. The relative results for the matrix phase of dental amalgam (Gamma-1) with and without tin confirm the importance of the tin oxide film in reducing substantially the mercury release. The results for the matrix phase without tin (Ag-Hg) may be indicative of the release from a bare amalgam surface following abrasion, since abrasion removes the protective oxide film. Future tests under conditions of abrasion will determine if abrasion further accelerates the mercury release by the mechanical disturbance of the substrate below the film. The difference between the results for the synthetically prepared matrix phase (Gamma-1 (1% Sn) and commercial dental amalgams indicate that in dental amalgams other alloying elements enhance the protective qualities of the surface films.

The results also showed the importance of the oxidizing processes within the liquid, which determine the proportion between the mercury oxidized and remaining dissolved, and mercury released into the vapor phase. Therefore, an additional study of the oxidation of mercury in the liquid was added as Specific Aim #2 for the next year of support.

3. HUMAN SUBJECTS

None

4. VERTEBRATE ANIMALS

None

5. PUBLICATIONS

M. Marek: The Release of Mercury from Dental Amalgam: The Mechanism and *in vitro* Testing. *J. Dent. Res.* **69**:1167-1174 (1990).

M. Marek: The Effect of Tin on the Corrosion Behavior of the Ag-Hg Phase of Dental Amalgam and Dissolution of Mercury. *J. Dent. Res.* **69**:1786-1190 (1990).