

STRUCTURE STUDY OF AMALGAM

IV. QUANTITATIVE DETERMINATION OF THE PHASES IN SILVER AMALGAM

by

HIKOSHI OTANI

KNUD DREYER JØRGENSEN

INTRODUCTION

The purpose of the present work is a quantitative determination of the three phases (γ , γ_1 , and γ_2) in silver amalgam as influenced by the mercury content of the amalgam. Knowledge of the relation between residual mercury content and the amounts of the different phases is of importance for understanding the setting process as well as the corrosion and mechanical properties of the amalgam.

MATERIALS AND METHODS

The amalgam specimens were all prepared from one alloy (True Dentalloy, The S. S. White Dental Mfg. Co., G.B.), which was amalgamated with pestle for 20 seconds in a Wig-L-Bug. Three groups of specimens were then obtained by condensation at different pressures in a steel cylinder as described by *Jørgensen et al.* (1964), and the mercury content determined by the method specified by *Jørgensen & Nielsen* (1964). Two specimens of about 10 mm length and 5 mm diameter were prepared for each group. The mercury content of the specimens in the three groups was 38.0, 42.0, and 45.2 weight percentage, respectively.

Other specimens were prepared by mixing weighed amounts of alloy and mercury without subsequent condensation. They had the shape of irregular balls with diameters of about 7 mm. The mercury content of these was 46.0, 50.0, 54.0, 58.0, and 62.0 weight

percentage, respectively. Two specimens were also prepared for each of these groups.

All specimens were embedded in a cold-curing plastic material, Palatal, the temperature of which did not raise beyond 30° C during polymerization. The preparations were then ground so that the cylindrical specimens presented a rectangular, plane surface of about 5 × 10 mm, while the free surface of the ball-shaped specimens was approximately circular with a diameter of about 7 mm. Finally, the preparations were relief-polished with a dilute suspension of very fine-grained powder of diatomaceous earth.

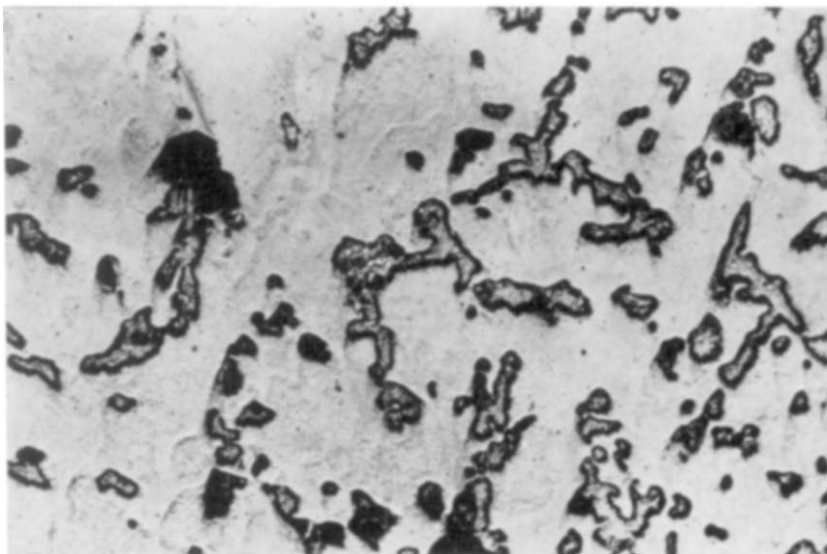


Fig. 1. Relief-polished amalgam with sharply defined grains of the γ_2 -phase. $\times 225$.

After relief-polishing the γ_2 -phase is very distinct in ordinary metallographic light (Fig. 1); the microscopic analysis was carried out with Leitz Opak-Illuminator at a true magnification of 68.5 times. The quantitative determination of the γ_2 -phase was made by the Point Counter method. In the cylindrical specimens 160 points at intervals of 50 μ were counted in each of five longitudinal profile lines parallel to the cylinder axis (800 points per specimen, 1600 points per group of the same mercury content. In the ball-shaped specimens 100 points were counted in the

same way in each of eight parallel lines (800 points per specimen, 600 points per group with same mercury content). The porosity of the specimens was counted at the same time as the γ_2 -phase.

After etching with 30 % nitric acid for 15 seconds the γ -phase was determined in the same areas and in the same way as the γ_2 -phase using Leitz Ultropak technique with a true magnification of 205 times.

When counting of γ -phase, γ_2 -phase and porosity was finished the percentage volume of the γ_1 -phase was computed by subtraction.

RESULTS AND DISCUSSION

The data are presented in Table I and in the diagram, Fig. 2. The most conspicuous result of the study is demonstration of

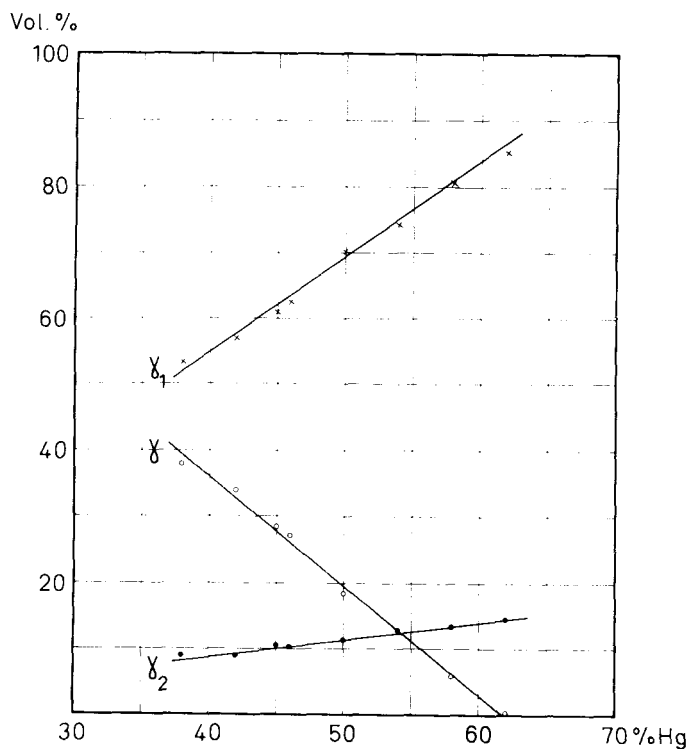


Fig. 2. The relation between mercury content of the amalgams studied (weight percent) and volume of the phases γ , γ_1 , and γ_2 .

Table I

Relation between the mercury content of the amalgams (in weight percent and the volume of the γ , γ_1 and γ_2 -phases, and of the porosity.

Mercury content	γ -phase	γ_1 -phase (computed)	γ_2 -phase	γ_1/γ_2	Porosity
38.0	37.8	53.2	9.0	6.0	0.8
42.0	34.0	57.0	9.0	6.3	0.3
45.2	28.6	60.7	10.7	5.7	1.0
46.0	27.2	62.5	10.3	6.0	1.4
50.0	18.6	70.0	11.4	6.1	1.3
54.0	13.0	74.2	12.8	5.8	1.0
58.0	6.0	80.4	13.5	5.9	0.3
62.0	0.4	85.0	14.6	5.8	0.3

direct proportionality between the mercury content of the amalgam and the volume of both the γ_1 -phase and the γ_2 -phase. This proportionality is apparent from the diagram as well as from the calculated proportion between γ_1 and γ_2 in the table. The mean proportion is 5.97 ± 0.20 . The slope of the γ_1 -curve is 1.40, of the γ_2 -curve 0.22. The finding suggests that both the reaction phases have constant composition within the whole dental range studied, and that the setting reaction of the amalgam is best compared to a simple stoichiometrical reaction.

SUMMARY

This is a study of the relation between the mercury content of dental amalgam and the amount of the different phases in the set amalgam. The results demonstrate that the mercury content is directly proportional both to the γ_1 -phase and to the γ_2 -phase. This finding indicates that the reaction phases of the amalgam have constant composition throughout the dental interval, and that the setting reaction of the amalgam is best compared to a simple stoichiometrical reaction.

RÉSUMÉ

ETUDES SUR LA STRUCTURE DE L'AMALGAME

IV. DÉTERMINATION QUANTITATIVE DES PHASES DANS L'AMALGAME D'ARGENT

Une étude a été faite sur le rapport existant entre la teneur en mercure des amalgames dentaires et la quantité des différentes

phases dans l'amalgame après sa prise. Les résultats montrent qu'il existe un rapport de proportionnalité directe entre la teneur en mercure et les deux phases (pente pour la phase 1: 1,40; pente pour la phase 2: 0,22). Les résultats semblent indiquer que les phases de réaction de l'amalgame ont une constitution constante dans tout l'ensemble de la zone dentaire, et que la réaction de prise de l'amalgame peut avantageusement être comparée à une simple réaction stœchiométrique.

ZUSAMMENFASSUNG

STRUKTURUNTERSUCHUNGEN VON AMALGAM

IV. QUANTITATIVE BESTIMMUNG DER PHASEN IN SILBERAMALGAM

Über den Zusammenhang zwischen dem Quecksilbergehalt dentalen Amalgams und der Menge der einzelnen Phasen in dem abgebundenen Amalgam ist eine Untersuchung durchgeführt worden. Die Ergebnisse zeigen, dass zwischen dem Quecksilbergehalt und sowohl der γ_1 -Phase (Neigungskoeffizient 1,40) als auch der γ_2 -Phase (Neigungskoeffizient 0,22) geradezu Proportionalität besteht. Die Ergebnisse deuten darauf, dass die Reaktionsphasen des Amalgams im ganzen dentalen Bereich eine konstante Zusammensetzung haben und dass sich die Abbindungsreaktion des Amalgams am besten mit einer einfachen stöchiometrischen Reaktion vergleichen lässt.

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Address: *Royal Dental College,
160 Jagtvej,
Copenhagen Ø, Denmark.*