NATIONAL BUREAU OF STANDARDS REPORT

9984

Progress Report

on

THE PARTICLE SIZE AND SHAPE OF SILVER ALLOYS FOR DENTAL AMALGAM

NBS

U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

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The Bureau comprises the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, and the Center for Radiation Research.

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THE INSTITUTE FOR MATERIALS RESEARCH conducts materials research leading to methods, standards of measurement, and data needed by industry, commerce, educational institutions, and government. The Institute also provides advisory and research services to other government agencies. The Institute consists of an Office of Standard Reference Materials and a group of divisions organized by the following areas of materials research:

> Analytical Chemistry—Polymers—Metallurgy — Inorganic Materials — Physical Chemistry.

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> Building Research—Electronic Instrumentation — Technical Analysis — Product Evaluation—Invention and Innovation— Weights and Measures — Engineering Standards—Vehicle Systems Research.

THE CENTER FOR RADIATION RESEARCH engages in research, measurement, and application of radiation to the solution of Bureau mission problems and the problems of other agencies and institutions. The Center for Radiation Research consists of the following divisions:

> Reactor Radiation—Linac Radiation—Applied Radiation—Nuclear Radiation.

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D. C. 20234.
[2] Located at Boulder, Colorado 80302.
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THE PARTICLE SIZE AND SHAPE OF SILVER ALLOYS FOR DENTAL AMALGAM

by

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This investigation is part of the dental research program conducted by the National Bureau of Standards, in cooperation with the Council on Dental Research of the American Dental Association; the National Institute for Dental Research; the Dental Research Division of the U. S. Army Medical Research and Development Command; the Dental Sciences Division of the School of Aerospace Medicine, USAF; and the Veterans Administration.

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The dental profession, today, may purchase a large number of excellent silver alloys for amalgam restorations since there are now more than 90 alloys on the List of Certified Materials of the American Dental Association.

The modern trend in these alloys has been toward the finer particle size because the resulting surfaces after carving are smoother. This is shown in Figure 20-8 of Skinner and Phillips.[(1)] In addition, the work of Demaree and Taylor[(2)] on spherical alloy particles showed definite relationships between particle size or area and dimensional change during hardening, mercury content, and early strength.

It is the purpose of this paper to show the large variation in particle size and shape that exists between many of the present day alloys. The particle sizes of 54 dental amalgam alloys were examined by means of photomicrographs and by measurement of maximum particle thickness.

The maximum thickness was determined by the following method:

The combined thickness of two optical flats (2 x 2 x 0.4 cm) is measured with a micrometer caliper. The value as

determined is the average of 10 measurements made in duplicate at the center and at the four corners. A few particles of alloy are dispersed at the center and near each corner of the surface of one of the flats so that no particles touch each other. The second flat is placed firmly on top of the particles and the thickness is again measured. The difference in the average thickness of the flats, with and without the particles, is recorded as the maximum thickness of the alloy particles (Table 1, last column).

In order to obtain additional information on the size and shape of the alloy particles a 4 x 5 inch photomicrograph having a 100X magnification was prepared for each alloy. Figures 1, 2 and 3 show representative sections of these photomicrographs.

Because the method for determining particle thickness measures the maximum thickness, length and width measurements were made on the three largest and most distinct particles in the original 4 x 5 inch photomicrograph using a millimeter scale. The average values for length and width are reported in Table 1.

Each of the alloys had wide variations in particle size with some of the finer particles estimated to be 1 to 3 microns in dimension. Excluding spherical particles, the length of the large particles range from 60 to 320, the width from 10 to 70 and the thickness from 10 to 35 micrometers.* The extremely wide variation in particle size and shape is shown in Figures 1, 2 and 3.

The length-to-width ratio (Table 1) varied from 2 to 25, which indicated that particle shape for some alloys is short and wide while other alloys are composed of particles which are needlelike in appearance.

Several of the alloys appear to be thicker than they are wide (Table 1). This may be due to differences in the two methods of measurement or to the presence of a few large particles in the samples placed between glass plates, but not observed in the photomicrograph.

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* The micrometer (μm) is an internation unit of length that has replaced the micron (μ) and is equal to it.

No correlation was found between particle size and the dimensional change during setting, flow, tensile strength, and mercury content of the resulting amalgams. This absence of correlation may result from two factors. First, during trituration the alloy particle may be reduced in size by fragmentation which could result in a much larger surface area being available for amalgamation. Second, other characteristics of the alloy such as composition, mechanical stresses, heat treatment, surface and the possible existence of internal surfaces may compensate for differences which would be observed if only particle size were varied.

Since these characteristics may vary widely in the alloys, the absence of an observable correlation between particle size and physical properties is not unexpected. In the work of Demaree and Taylor [2], on the other hand, variations other than particle size were eliminated and correlation between particle size and properties were observed.

Table 1

Average Dimensions of the Largest Particles

Alloy		Length **	Width **	L/W Ratio	Thickness †
No.*	Brand				
		μm‡	μm		μm
1	Accurate Metalloy	140	20	7	25
2	Aristaloy	60	10	6	10
3	Baring (Improved fine cut)	100	10	10	20
4	Brewster	180	20	9	20
5	Certified Non-Zinc	100	20	5	15
6	Cresilver	200	20	10	30
7	Dispersalloy 325	120	40	6	40
8	Dispersalloy 400	120	30	3	30
9	Ex-Cell	320	30	11	15
10	Fellowship	320	70	5	20
11	Filling Alloy - Abe Bass	130	10	13	15
12	Filling Alloy - Pure Lab	120	10	12	20
13	Garfield's	120	10	12	20
14	Gold Bond	140	40	$3\frac{1}{2}$	35
15	Linc Alloy	100	10	10	10
16	Lustraloy Regular	220	30	7	15
17	Merrick - Fine Cut	120	30	4	10
18	Merrick - Non-Zinc	170	30	6	10
19	Midvalloy	150	20	$7\frac{1}{2}$	15
20	Minimax #178	130	20	$6\frac{1}{2}$	25
21	Minimax #178 Non-Zinc	200	20	10	25
22	Minimax #183	250	10	25	20
23	Modeloy	160	20	8	20
24	Mynol Improved	110	10	11	10
25	National Dental	120	20	6	20

*These numbers correspond to the numbered sections of the photomicrograph.

** Average of three largest particles.

† The data for thickness has been rounded to the nearest 5 micrometers.

‡μm = micrometer (formerly the micron).

Table 1
(continued)

Alloy No.	Alloy Brand	Length	Width	L/W Ratio	Thickness
		μm	μm		μm
26	Peerless	100	10	10	10
27	Precision	90	20	4½	30
28	Royal	130	10	13	15
29	Safco 69 Fine Cut	120	20	6	20
30	Safco 69 Fine Cut Non-Zinc	110	20	5½	20
31	Safco 69 Regular	120	20	6	25
32	Safco 72 Fine Cut Non-Zinc	110	10	11	15
33	Safco 72 Regular Non-Zinc	150	20	7½	15
34	S-C Special Medium	130	20	6½	15
35	S-C Special Quick	210	40	5	20
36	Shofu	50	30	--	30
37	Silver Crown Super Fine	100	30	3	15
38	Silver Crown Super Fine Non-Zinc	80	30	3	10
39	Silver Crown Medium	250	70	3½	25
40	Silverloy	310	50	6	20
41	Spheraloy	40	40	--	35
42	Standard	300	70	4½	30
43	Theta Superb	230	30	8	15
44	True Dentalloy - New	130	70	2	20
45	True Dentalloy Regular	240	20	12	30
46	True Dentalloy Zinc Free	140	30	5	25
47	Twentieth Century Fine Cut	160	30	5	20
48	Twentieth Century Micro	140	30	5	15
49	Twentieth Century Micro Non-Zinc	100	30	3	15
50	Twentieth Century Regular	310	70	4½	20
51	Ultra Brand 68% Regular	110	30	4	25
52	Ultra Brand 72% Fine Cut	190	30	6	25
53	Ultra Brand 72% Fine Cut Non-Zinc	170	30	6	30
54	White Beauty	210	60	3½	15

REFERENCES

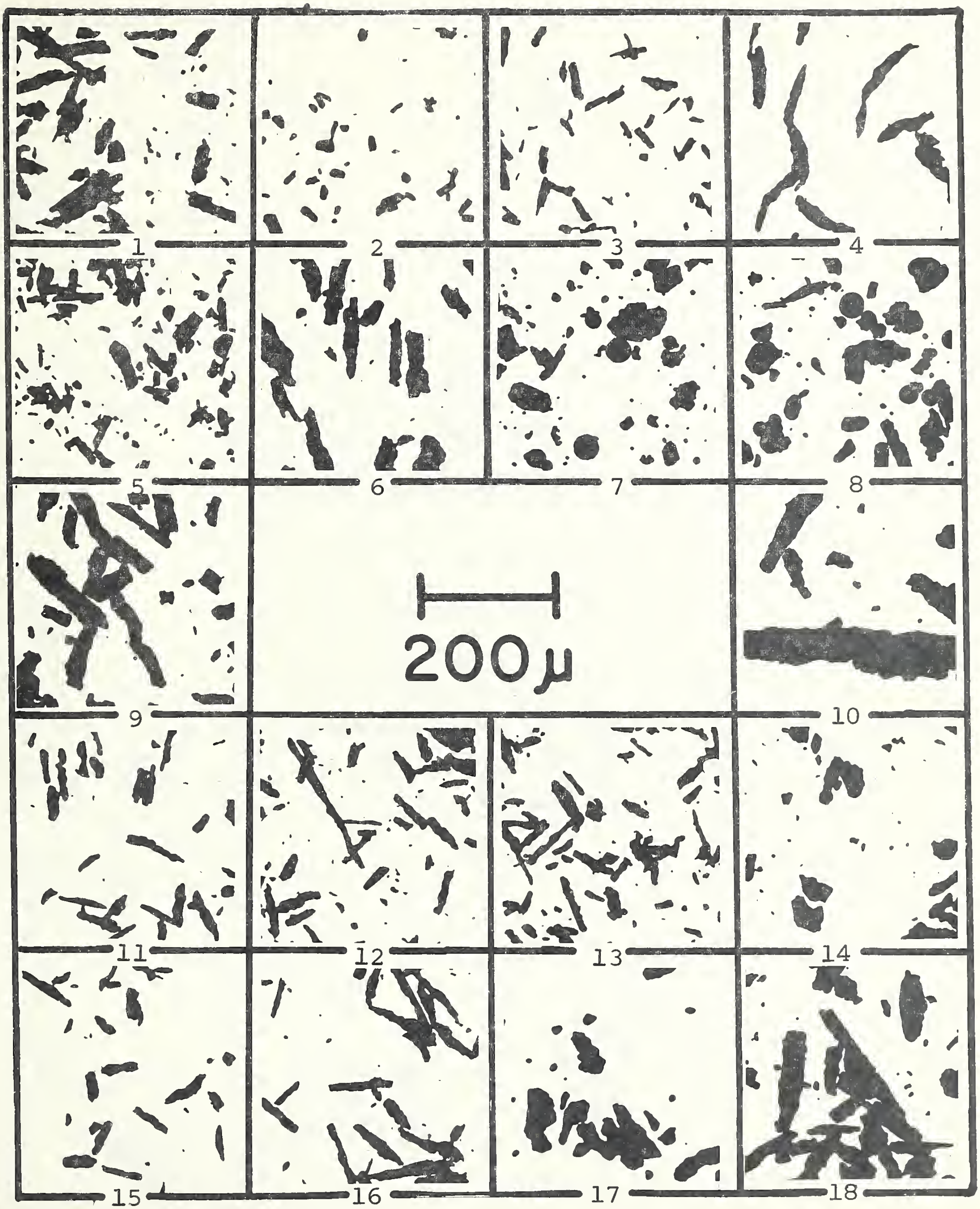
1. Skinner, E. W. and Phillips, R. W. The Science of Dental Materials, 6th edition, W. B. Saunders Co., Philadelphia, 1967.

2. Demaree, N. C. and Taylor, D. F. Properties of Dental Amalgam Made from Spherical Alloy Particles, J. D. Res. 41: 890 July-Aug, 1962

Certain commercial materials are identified. In no case does such identification imply recommendation or endorsement by the National Bureau of Standards, nor does it imply that the material is necessarily best for the purpose.

Legends for Figures 1, 2 and 3

Amalgam alloy particles. The photomicrograph for each alloy is a representative 1-1/2 x 1-1/2 inch section taken from an original 4 x 5 inch photomicrograph. The numbers correspond to those in Table 1.



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