Silver – Tin Dental Amalgam Alloy Manufacturing By Rapid Quenching Method .

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Abstract. A silver – tin alloy was prepared by melting .at 1000 C^0 , in inert atmosphere and rapid quenching in ice water . X –ray diffraction technique was used to determine distinctive phases without and with mercury (Amalgam) .Discs amalgam specimens were prepared according to the international specifications (A.D.A No.1) to study the compressive strength after one hour of setting and after seven days at 37 C^0 .The margin hardness, contraction and expansion were tested too .The corrosion resistance of amalgam immersed in an aqueous solution of NaCl and in an phosphate (Na2 HPO4 and NaH2PO4) was tested . Compressive strength and hardness values obtained were batter than others types and equivalent to the international values .The amalgam alloy showed a clear corrosion resistance .The required phases represented in the domination of [Gama- Ag3Sn] phase and the disappearing of [Gama2 – Sn – 8Hg] phase ,which cause the corrosion .

INTRODUACTION

The dental amalgam alloys to be mixed with mercury to produce amalgam restoration are manufactured in tow basic physical forms . These are the older ,and still most commonly used ,irregular shaped ,particles produced by lath cutting , turning or filing and more recently developed is spherical particles alloys produced by atomization . Modern dental amalgam alloys consist of silver , tin ,copper and zinc or copper enriched with mercury .Variations in compositions are generally comply with the American Dental Associations or Federation Dentaire International specification . The most dental amalgam alloys must consist basically of a silver –tin .Copper when it is added in small or large quantities replaces some of the silver and is thought to impart the same desirable properties to the alloy as silver .Zinc ,where it is included in an aid to manufacturer during the manufacture of the alloy Zinc acts as a scavenger for oxygen and prevents the oxidation of the other ingredients . Mercury ,where present in a small quantities ,is provided to facilitate amalgamation ,and alloys containing mercury are known as activated alloys .These are popular in Europe .A dental analysis of the silver –tin phase diagram explained by Wing [(1)] ..Its simply a combination of solid solutions ,whit some peritectic reactions taking place and at least one intermetallic compound being formed and eutectic present in the tin-rich end of the system . It may generally be accepted that at the compositions used in the manufacturing of dental amalgam alloys, we have materials within the very narrow range of the intermetallic compound at the composition Ag3Sn(Silver 74% and Tin 26%) . The use of higher composition of silver may mean that instead of the single phase Gama material ,the original alloy may consist of either the Alpha silver-tin phase or, the Beta silver –tin phase or a mixture of these ,or a mixture of Gama and Beta materials .changes in composition of the original alloy ,away from the Gama composition will have marked effects on th00e subsequent properties of the amalgam after mixing with mercury .

EXPEREMANTLA WORK

Pure elements of (99.99) purity were used to prepare the alloy in the composition of Ag 68wt% -Sn29wt.% - Cu2.6wt.% - Zn0.4wt.% ,and melted at 1000 C^0 in a resistance furnace under inert atmosphere (Obtained by control flow of Argon) with heating rate 10 C^0 / min , followed by decreasing the temperature to 700 C^0 at

soaking time 30 mints . The melted alloy quenched in a high speed rotter container containing ice water ,to produce a very thin brittle flacks and solid thin alloy .Annealing at 400 C^0 for 24 hours is required . Soft milling was done to the thin solid alloy to get fine powder .Further annealing at 1000 C^0 for 3 hours applied to release all the residual stresses . X-ray diffraction was conducted to study the crystal structure of the fabricated alloy .Optical microscopy was done to identify the grain shape after quenching process .Amalgam alloy of 1:1mercury ratio were prepared in a discs of (4x4)mm, according to the (ADA No.1) [(2)] . These samples were mechanically tested by compression strength and marginal hardness after 1 hour and 7 days setting. In addition to the contraction and expansion 5 minutes after setting and final test after 24 hours at 37 C^0 .Corrosion resistance of amalgam samples has been tested too in aqueous of NaCl and in a buffer phosphate for one month and 3 months respectively under control atmospheric temperature 37 C^0 .

RESULTS AND DISCUSSION

X-ray diffraction pattern of the quenched alloy can be seen in figure (1),and shows that the dominate phase (Required) is [Gama – Ag3Sn] phase which can be obtained and analyzed the height of peaks which used to identify the phases according to the ASTM file (no.3-713.). No existing of the[Gama2 –Sn7-8Hg] (Unrequired) phase[(3)] . Optical micrographs showing the clear semi spherical shapes for the quenched particles alloy as seen in figure (2) and in figure(3) which showing more clearness of the particles after annealing at 400 C^0 , having a sphericity value of 0.7 .This can be explain as a resulting of higher rotation cold medium that may effect the surface tension of the melting particles to produce a semi spherical particle shape .The amalgam compressive strength after one hour and 7 days latter, and indicated a batter values comparing with other alloys as shown in table (1) ,and showing an initial contraction of 2(µm/cm) and expansion of 10(µm/cm) which is within the international permeation value (20µm/cm) .Hardness and corrosion resistance[(4)] gives consistence results with the compressive strength ,as shown in table (1) . The amalgam alloy showed a clear corrosion resistance through the low dissolution of Ag,Cu,Sn and Zn .Those batter values opiated is du to the formation of the [Gama –Ag3Sn] phase and disappearing of[Gama2-Sn7-8Hg] phase . [(5)] [(6)]

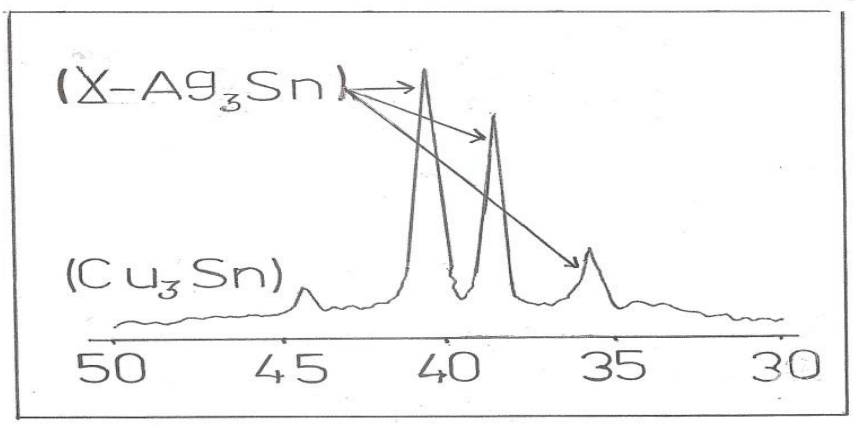

FIGURE 1 . X-ray diffraction pattern for the Silver – Tin Amalgam alloy , manufactured by quenching method

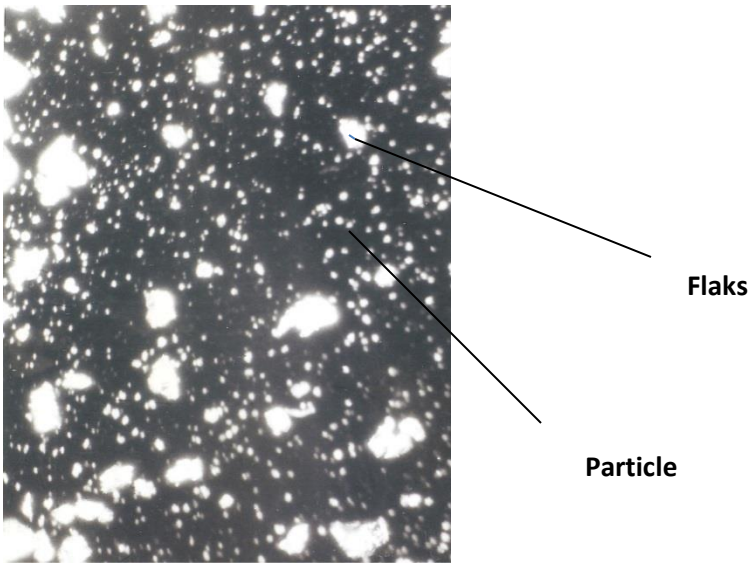

FIGURE 2. Optical micrograph , (X1000), of the Silver –Tin alloy manufactured by quenching method and before annealing .

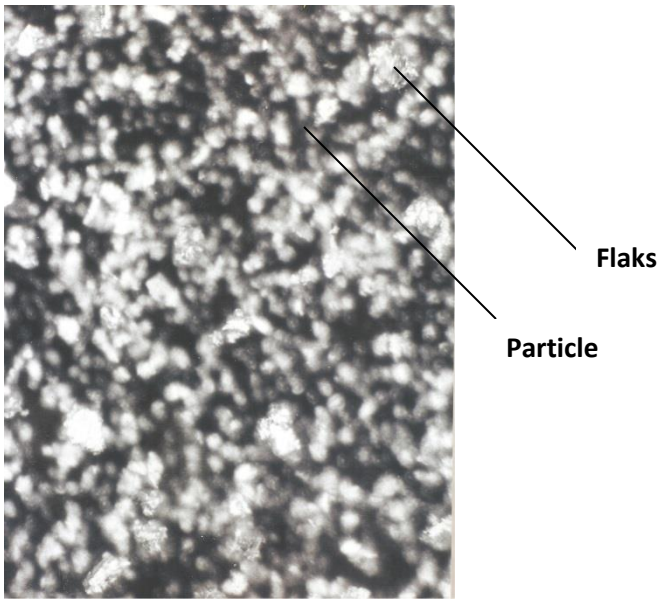

FIGURE 3. Optical micrograph , (X1000), of the Silver –Tin alloy manufactured by quenching method after annealing at 400 C^0 **.**

TABLE (1).The Compressive strength , hardness and corrosion resistance of Silver- Tin amalgam alloy manufactured by different methods .

Alloy Particle shape	Compressive strength MN/M^2	Hardness (VHN)	Ag Corrosion (mg/ml) in NaCl	Ag Corrosion (mg/ml) in Buffer Phosphate
Semi Spherical (Quenched method)	1 hour after setting 130 24 hours after setting 310	56 56	1 month >0.03 3 months >0.03	1 month >0.03 3 months >0.03
Needle (Lath cut method)	1 hour after setting 46 24 hours after setting 210	54 54	1 month >0.03 3 months >0.03	1 month >0.03 3 months >0.03
Spherical (Atomizing methode)	1 hour after setting 96 24 hours after setting 218	54 54	1 month >0.03 3 months >0.03	1 month >0.03 3 months >0.03

CONCLUSIONS

The sliver-tin amalgam alloy produced by quenching method shows the formation of desirable phase[Gama – Ag3Sn] and disappearing the undesirable [Gama2 –Sn7-8Hg] phase .The sphericity value(0.7) indicated the semi spherical shape specially after annealing at 400 C^0 . The compression , marginal hardness a, longitudinal expansion and the corrosion resistance values are fitted with the international standard (ADA No.1) .

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