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PLASTIC ALLOY WHICH SETS AT ROOM TEMPERATURE

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This invention relates to an alloy composition which is plastic slightly above room temperature when first prepared but which hardens upon standing. These and other properties make the alloy suitable for forming molded products, especially compacted fillings used in tooth restorations.

Mercury - containing metallic compositions, known as amalgams, have been commonly employed heretofore where moldability at room temperature and subsequent hardening of the molded mass have been required. They have found special application in the filling of tooth cavities because of the hardness they attain and the tight fit which it is possible to achieve by packing the plastic body into a cavity and by the expansion which occurs during setting. However, the amalgams do not wet the tooth or form a bond therewith and consequently some separation may occur in time.

The amalgams are usually prepared by triturating together predetermined proportions of mercury and a solid metal or alloy in finely divided condition. Generally, more mercury is used than is required to form the final hardened body in order to insure a rapid and thorough mixing of the components and supply all the mercury that may be needed. Before the amalgam is molded or pressed into the desired shape, it is therefore necessary to squeeze out or express the excess mercury. The operation is time-consuming and wasteful.

Although dental amalgams have been extensively used, they are still open to the additional objection that mercury is toxic. In spite of these disadvantages, amalgams have been regarded as the only practical metallic materials for molding at room temperature. It is accordingly a principal object of this invention to overcome these disadvantages and to provide a new improved moldable mixture containing no mercury.

I have discovered that a superior molded product can be made of an initially plastic composition consisting essentially of 49 to 74% by weight of nickel, 25 to 45% gallium and 0.5 to 7.5% silicon. Other elements may be present as impurities or intentional additions if they do not substantially alter the characteristics of the alloy. The product formed from this alloy is non-toxic, attains a Brinell hardness of 80 to 150 upon standing 48 hours at room temperature after preparation and compaction, and it also hardens with sufficient rapidity to be useful in filling tooth cavities. The foregoing hardness values refer to those obtained by use of a $\frac{1}{8}$" diameter steel ball under a load of 12.61 kgs. applied for a period of 30 seconds. In addition, the alloy forms a tight bond with a tooth and no excess gallium is required to form the plastic composition. A slight expansion of the alloy occurs during setting, within the limits specified for amalgams, which is also advantageous in dental work.

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In my preferred practice the alloy should consist of 62 to 66% by weight of nickel, 32 to 37% gallium and 1 to 2% silicon, which alloy will attain a Brinell hardness of 100 to 120 after standing 48 hours.

The nickel-silicon base may be prepared by mixing together the two metals in powder form in the proper proportions, or, the metals may be melted to form an alloy, the alloy cast in cylindrical shape, machined to produce chips and the chips then milled to provide the desired particle size. Other methods of preparing the comminuted alloy may be employed, of course, as long as the proper particle size is obtained.

To form the gallium-containing alloy the foregoing base composition in finely divided condition is admixed with the proper proportion of gallium. Inasmuch as gallium melts at about 30° C. (87° F.) it is most convenient to warm it slightly to form a liquid and mix the liquid with the base alloy powder. However, solid gallium may be added to the powder mixture and the temperature of the mass raised to a point when the mass becomes plastic or the gallium melts. In any case, the gallium-containing alloy should be in a plastic condition when mixed or triturated. Once the plastic alloy is prepared there is generally no difficulty in maintaining the desired plastic condition long enough to permit molding or filling a cavity in a tooth.

The amount of gallium required to produce the desired plasticity and permit the attainment of a minimum Brinell hardness of 80 in the hardened product lies within the range of 25 to 45% by weight of the alloy, and preferably the proportion should be 32 to 37%. Also, within these limits all of the gallium is absorbed in forming the plastic mixture, consequently, there is no need for a preliminary squeezing or expression to remove excess gallium prior to molding or compacting the alloy.

The mixing or trituration of the gallium and nickel-silicon base composition is preferably carried out in the conventional type of mortar and pestle apparatus employed in preparing amalgams. The period of mixing will vary, ordinarily, between ½ and 5 minutes, but should,

in any event, be long enough to produce a uniform moldable mass.

The resulting alloy appears to be drier than the usual amalgam; however, it is still sufficiently plastic to be as readily formed or compacted as an amalgam. In spite of the apparent dryness of the alloy, it has a greater wetting power than amalgams and tends to cling to a tooth or other non-metallic material against which it is pressed. As a result, there is no zone of imperfect contact between the tooth or other wetted body and the gallium-containing filling and a firm lasting bond is thus assured.

Once the gallium-containing alloy is prepared it should be immediately molded or pressed into the desired shape. The compacting or condensing operation may be conducted in the same manner as that followed in handling the conventional dental amalgams. If the alloy has been properly mixed and compacted, the final rigid product will meet the requirements of the Federal Specifications for dimensional change and flow of amalgams. The hardness, attained, however, is actually greater than that which usually characterizes dental amalgams. A range of 60 to 63 is commonly specified for amalgams 24 hours after they have been compacted.

It has been found that the desired results are obtained by employing a comminuted mixture

of 90 to 99% by weight of nickel and 1 to 10% silicon in either elemental or prealloyed form, as mentioned above. It is important, in any event, that the final product be in sufficiently finely divided form to be readily admixed with the gallium, and to set rapidly.

My invention may be illustrated by the following example. A mixture of nickel and silicon powders was prepared which consisted of 63 parts nickel and 1 part silicon. The metallic mixture was then triturated with 36% by weight of gallium at 35° C. for a period of 5 minutes. The resultant alloy which had a dry appearance was packed in a mold with a tool and tested according to Federal Specification U–A–451*a*. The dimensional change was found to be +4.8μ/cm. and the flow percentage was 2.9, both values coming within the range set forth in the aforesaid Federal Specification. In addition, it was found that the compacted product had a Brinell hardness of 107 after standing 48 hours.

Having thus described my invention and one embodiment thereof I claim:

1. An alloy composed essentially of 49 to 74% nickel, 25 to 45% gallium and 0.5 to 7.5% silicon.

2. An alloy consisting of 62 to 66% nickel, 32 to 37% gallium, and 1 to 2% silicon.

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No references cited.