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ORTHODONTIC METHOD

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ABSTRACT OF THE DISCLOSURE

This invention relates to a method of securing brackets to teeth and more particularly, to a method whereby the brackets are secured directly to the teeth rather than to tooth bands, by using an ionic hydrocarbon copolymer film. The brackets can be easily removed when desired by merely remelting the ionic hydrocarbon copolymer.

BACKGROUND OF THE INVENTION

Orthodontia is the branch of dentistry that is concerned with the straightening of teeth. In practice, straightening of teeth is frequently accomplished through the use of arch wires that are secured to orthodontic devices that are in turn secured to the teeth. By properly tensioning the arch wires the crooked teeth can be straightened. The conventional orthodontic method includes the step of encircling selected teeth with bands. Such tooth bands have been frequently made from stainless steel. To the tooth bands are secured small brackets to which the arch wire is connected.

The stainless steel tooth bands have given rise to several problems. First of all, a supply of various size bands must be kept on hand to suit particular requirements. The requisite supply is oftentimes very large, sometimes consisting of several thousand dollars worth of bands. Secondly, the bands provide a site for decay to form. Thirdly, the bands hamper efficient cleaning of the teeth. And lastly, the bands require a certain amount of space between the teeth, space that later must be filled in.

We are familiar with several prior orthodontic methods that have attempted to eliminate tooth bands. In such methods organic adhesives, such as epoxy resins, have been used to secure the brackets to the teeth. However, these methods, while eliminating the use of tooth bands and their attendant problems, have also presented several new problems.

OBJECTIVES OF THE INVENTION

It has been the objective of this invention to provide a method for rapidly securing brackets directly to teeth whereby an almost instantaneous bond between tooth and bracket is obtained. It has also been an objective of this invention to provide such a method where the brackets can be easily removed from the teeth. Another objective has been to provide such a method that is easy to practice and that provides a tenacious bond between the bracket and the tooth.

SUMMARY OF THE INVENTION

We have found that a bracket can be secured directly to a tooth through the use of a thin film of an ionic hydrocarbon copolymer that is interposed between the tooth and bracket, melted and allowed to solidify. By using our method the bands and their attendant problems are altogether eliminated. Brackets can be rapidly secured to teeth and there is, practically speaking, no setting time required for the ionic hydrocarbon copolymer. Brackets so secured withstand the stresses and forces to which they are normally subjected. The brackets can be easily removed when desired by merely remelting the ionic hydrocarbon copolymer. With this method the time and cost of orthodontia are greatly reduced.

In practicing our orthodontic method we use as the bonding medium between the tooth and bracket, a plastic film formed from a class of hydrocarbon polymers commonly referred to as ionic hydrocarbon polymers, so named because they contain ionic crosslinks. The polymers and the specific methods by which they may be prepared are fully described and claimed in U.S. Patent No. 3,264,272, the disclosure of which is incorporated by reference herein. A polymer is manufactured by the assignee of said patent, the E. I. du Pont de Nemours & Co., Inc., and sold under the trademark Surlyn A 1601. This polymer is well adapted for use in my process since it is non-toxic and can be safely used in the mouth.

To melt the ionic hydrocarbon polymer after it has been positioned between the tooth and bracket we prefer to heat the surface of the bracket by means of induction heating. The principles of induction heating are very well known. It is the characteristic of induction heating that only the metal surface is heated. Therefore, by using this method we apply heat precisely at the location required. Briefly, this type of heating makes use of the physical phenomena that when alternating current flows through a conductor, a symmetrical electromagnetic field is established around the conductor. When the conductor assumes the shape of a coil, the electromagnetic field is intensified. The intensity of the field is dependent upon the magnitude of the current passing through the conductor and the number of turns in the coil. If an electrically conductive material, as for instance a stainless steel tooth bracket, is placed within the coil, then current is caused to flow through the bracket. The magnitude of the "induced" current is determined by the intensity of the magnetic field and by the spacing of the bracket with respect to the coil. The resistance of the bracket to the induced current causes the surface of the bracket to heat up. This heating is therefore referred to as "induction heating." This type of heating is especially useful in the practice of my method since the temperature of the bracket can be accurately controlled and the heat generated can be confined to the surface of the bracket. While I do prefer to use induction heating it would, of course, be possible to practice my process by using resistance heating of the bracket or even to heat the bracket by means of a laser beam.

A discussion of induction heating may be found at pages 352 and 353 of "The Encyclopedia of Electronics" published in 1962 by Reinhold Publishing Co. There may also be found there several equations that may be helpful in determining the magnitude of the current needed etc. which are, of course, known in this art.

An induction heating coil that we have used is one made from a flat, spiral wound $^3/_{32}$ inch outside diameter copper tube. The coil consisted of 3 coils and was water cooled. An RF current was induced in the spiral oscillating at 1.3 megacycles. In practice similar equipment would cost less than the inventory of bands currently required.

PREFERRED EMBODIMENT

In practice I have secured brackets to teeth in the following manner. The brackets that were used were made from stainless steel. Their bases ranged in size from 3½ mm. wide and 5 mm. long to 7½ mm. wide and 5 mm long. They were approximately 5 thousandths of an inch thick. Surlyn A 1601 film strips having a thickness of between 1 and 3 mils were cut so as to provide pieces having the approximate size of the bracket bases. The bases of the brackets were placed against the teeth with the Surlyn film strips placed there between. The induction heating coil described above was used to heat the surface of the brackets to about 500° F. At this temperature the

film strips melted. The heating was discontinued and the brackets were then allowed to cool while in pressure contact with the teeth. Upon solidifying, the film secured the bracket to the tooth. The bond between the brackets and the teeth was such that arch wires could have been secured thereto in conventional fashion.

Having thus described our invention we claim:

1. A method for securing a bracket to a tooth which comprises:

interposing between said tooth and said bracket an ionic copolymer of an a-olefin having the formula $R—CH=CH_2$, where R is a radical selected from the class consisting of hydrogen and alkyl radicals from 1 to 8 carbon atoms and a,b-ethylenically unsaturated carboxylic acids having from 3 to 8 carbon atoms, said copolymers having from 10% to 90% of the carboxylic acid groups onized by neutralization with metal ions uniformly distributed throughout the copolymer, said copolymer being a direct copolymer of the a-olefin and the unsaturated carboxylic acid in which the carboxylic acid groups are randomly distributed over all molecules and in which (1) the a-olefin content of the copolymer is at least 50 mol percent, based on the a-olefin-acid copolymer, (2) the unsaturated carboxylic acid content of the copolymer is from 0.2 to 25 mol percent, based on the a-olefin-acid copolymer, and (3) any other monomer component optionally copolymerized in said copolymer is monoethylenically unsaturated, and said metal ions having an ionized valence of from one to three inclusive when the unsaturated acid is a monocarboxylic acid and an ionized valence of one when the unsaturated acid is a dicarboxylic acid and said metal ions being selected from the group consisting of uncomplexed and complexed metal ions, said ionic copolymers having solid state properties characteristic of crosslinked polymers and melt-fabricability properties characteristic of uncrosslinked, thermoplastic polymers.

heating said ionic copolymer to a temperature sufficient to melt it,

holding said bracket against said tooth, and

allowing said ionic copolymer to cool and solidify.

2. A method of securing a bracket to a tooth that comprises:

interposing between said tooth and said bracket an ionic copolymer of ethylene and an a,B-unsaturated monocarboxylic acid having from 3 to 8 carbon atoms, said copolymers having from 50% to 80% of the carboxylic acid groups ionized by neutralization with metal ions having an ionized valence of from one to three inclusive uniformly distributed throughout the copolymer, said metal ions being selected from the group consisting of uncomplexed and complexed metal ions, said copolymer being a direct copolymer of ethylene and the unsaturated monocarboxylic acid in which the carboxylic acid groups are randomly distributed over all molecules and in which the ethylene content of the copolymer is from 90 to 99 mol percent, based on the ethylene-acid copolymer, and the unsaturated monocarboxylic acid content of the copolymer is a complementary amount from 10 to 1 mol percent, based on the ethylene-acid copolymer, said ionic copolymers having solid state properties characteristic of crosslinked polymers and melt-fabricability properties characteristic of uncrosslinked, thermoplastic polymers,

heating said bracket to a temperature sufficient to melt said ionic copolymer,

holding said bracket against said tooth,

discontinuing said heating, and

allowing said ionic copolymer to solidify.

3. The method of claim 2 wherein said bracket is heated by induction heating to a temperature of approximately 500° F.

4. The method of claim 3 wherein said ionic copolymer is in the form of a film.

5. The method of claim 4 wherein said ionic copolymer film has a thickness of about 1 to 3 mils.

6. The method of claim 2 wherein said olefin is ethylene and the a,B-ethylenically unsaturated carboxylic acid is monocarboxylic.

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