

root by failing at the gum line. Conventional metal posts and ceramic posts tend to cause a roof fracture when they break. The tooth then has to be extracted. If the material fails at the gum line, the root is spared and the tooth can be saved for retreatment.

There are many advantages to using this material for orthodontic brackets, specifically they can be highly translucent and thus almost transparent bracket. The bracket will tend to blend in with teeth and will be more aesthetic than current metal and ceramic brackets. The bracket has a greater toughness than existing materials and may be more resistant to failure than ceramic brackets. The ceramic brackets are used as an aesthetic alternative to metal but suffer from failure at the wings due to their brittle nature. The brackets also have less friction than ceramic brackets. One of the problems with the ceramic brackets is high friction with the wires thus prolonging treatment.

There are also many advantages of using the material for an implant abutment including the aesthetics, the ease of adjustment and decreased stress transfer. Conventional implant abutments must be custom made or custom adjusted in the laboratory. Also the prior metal abutments may transfer stress directly to the bone leading to accelerated bone resorption. The resin ceramic abutments may act as a shock absorber.

A direct filling material would be used by the dentist and placed directly on the tooth to rebuild missing tooth structure. This is commonly called a composite resin. Current composite resins are based on filling a fluid resin with micron/submicron glass or ceramic particles. These particles are not connected. This leads to problems with wear as the particles pull out and leave behind the relatively soft resin. Particle connection to the resin matrix is a significant problem. Also it is difficult to compress these materials into small spaces which often results in gaps between the filling material and the tooth, leading to recurrent decay and sensitivity.

The proposed new composite resin material is based on using interconnecting resin infused ceramic blocks to produce a powder with particle sizes approximately 10-100 microns. The blocks may be cryogenically milled or hammer milled to produce the starting powder. The particles would actually be interconnect ceramic and resin units. The particles may be silane treated before mixing with monomer to improve wetting of the particles with the monomer and bonding of the particles. The silane treatment includes infusing the blocks with a silane solution for 24 hours before heating them at approximately 100° C. for about 1 hour before resin infusion. The preferred silane solution is a 1 wt % 3-methacryloxypropyltrimethoxysilane in a 50/50 mixture of ethanol and water. The pH is adjusted with acetic acid to a value of about 4.

The particles would then be mixed with a light or heat curing resin (TEGDMA/UDM; BIS-GMA/UDM) similar to that described in the parent patent. This produces a viscous paste which can be directly applied to the tooth and cured. Subsequent adjustment and finishing procedures such as polishing allows the placement of the restoration in a single visit. Additional particles consisting of micron/submicron silica or ceramic may be added to the mixture to alter viscosity and mechanical properties. The total loading of the resin with filler will be in the range of 60-80% by volume. The advantages of this composite resin is two fold. First the filler material consists of interconnected resin-ceramic particle which improves bonding of the filler to the resin matrix and should result in decrease wear and improved mechanical properties. And second, the ability to compress this material is improved due to the interconnected filler units.

Other embodiments of the invention will be apparent to those skilled in the art from a consideration of this specification or practice of the invention disclosed herein. Although a detailed description and examples of the present invention has been provided above, it is to be understood these are exemplary and that the scope of the invention is not be limited thereby, but is to be determined by the claims which follow.

What is now claimed is:

1. A process for preparing a direct filling material which comprises:

milling a resin infused ceramic block to form a powder, the particles of the powder comprising interconnected ceramic and resin units;

coating said powder with a silane mixture to form a coated powder;

mixing the coated powder with a curable monomer to form a paste whereby when the resin is cured an interconnected ceramic and resin network is formed.

2. The method of claim 1 which comprises:

cyrogenically milling or hammer milling the block to form the powder.

3. The process of claim 1 wherein the curable monomer is selected from the group consisting essentially of hydroxy ethyl methacrylate; triethylene glycol dimethacrylate; 2,2bis [4(2-hydroxy-3methacryloyloxy-propyloxy)-phenyl] propane; urethane dimethylacrylate, biphenyldimethacrylate; n-tolyglycine-glycidylmethacrylate; polyethylene glycol dimethacrylate; or oligocarbonate dimethacrylic esters.

4. The method of claim 3 which comprises:

heat or light curing the resin.

5. The method of claim 3 wherein the ceramic block is selected from the group consisting essentially of feldspathic porcelain, a silica, alumina, metal oxide or glass.

6. The process of claims 1 or 3 wherein the resin infused to the ceramic is selected from the group consisting essentially of triethylene glycol dimethacrylate/urethane dimethyl acrylate, 2,2,bis[4(2-hydroxy-3 methacryloyloxy-propyloxy))-phenyl]propane/urethane dimethacrylate or oligocarbononate dimethacrylic esters.

7. A paste-like direct filling material which comprises:

resin infused ceramic particles, the particles comprising interconnected ceramic and resin units, said particles characterized by being silane treated; and

a curable monomer whereby when the paste-like filling material is cured an interconnected resin and ceramic network is formed.

8. The filling material of claim 7 wherein the curable monomer is selected from the group consisting essentially of hydroxy ethyl methacrylate; triethylene glycol dimethacrylate; 2,2bis [4(2-hydroxy-3methacryloyloxy-propyloxy)-phenyl] propane; urethane dimethylacrylate, biphenyldimethacrylate; n-tolyglycine-glycidylmethacrylate; polyethylene glycol dimethacrylate; or oligocarbonate dimethacrylic esters.

9. The filling material of claim 8 wherein the ceramic block is selected from the group consisting essentially of feldspathic porcelain, a silica, alumina, metal oxide or glass.

10. The filling material of claim 8 wherein the resin infused to the ceramic is selected from the group consisting essentially of triethylene glycol dimethacrylate/urethane dimethyl acrylate, 2,2,bis[4(2-hydroxy-3methacryloyloxy-propyloxy))-phenyl]propane/urethane dimethacrylate or oligocarbononate dimethacrylic esters.