DENTAL MILL BLANKS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 11/834,999, filed Aug. 7, 2007 now U.S. Pat. No. 7,845,947, which is a continuation of U.S. patent application Ser. No. 10/027,278, now U.S. Pat. No. 7,255,562, filed Dec. 21, 2001, which is a division of U.S. patent application Ser. No. 09/227,230, now abandoned, filed Jan. 8, 1999, all of which are incorporated in their entirety herein.

FIELD OF THE INVENTION

This invention is related to polymeric based mill blanks that are substantially free of cracks and are suitable for use in fabricating dental and medical prostheses by CAD/CAM (computer-aided design/computer-aided machining) procedures.

BACKGROUND OF THE INVENTION

The art of fabricating custom-fit prosthetics in the medical and dental fields is well-known. Prosthetics are replacements for tooth or bone structure; examples include restoratives, replacements, inlays, onlays, veneers, full and partial crowns, bridges, implants, posts, etc. Currently, most prostheses in dentistry are either made by hand by a dental practitioner while the patient is in the dental chair, or by an independent laboratory who is capable of such fabrication.

Materials used to make the prostheses typically include gold, ceramics, amalgam, porcelain and composites. For dental restorative work such as fillings, amalgam is a popular choice for its long life and low cost. Amalgam also provides a dental practitioner the capability of fitting and fabricating a dental filling during a single session with a patient. The aesthetic value of amalgam, however, is quite low, as its color drastically contrasts to that of natural teeth. For large inlays and fillings, gold is often used. However, similar to amalgam, gold fillings contrast to natural teeth hues. Thus, dental practitioners are increasingly turning to ceramic or polymer-ceramic composite materials whose color can be matched with that of the tooth.

The conventional procedure for producing dental prosthetics typically requires the patient to have at least two sessions with the dentist. First, an impression is taken of the dentition using an elastomeric material from which a cast model is made to replicate the dentition. The prosthetic is then produced from the model using metal, ceramic or a composite material. A series of steps for proper fit and comfort then follows. Thus, fabrication of custom prostheses involves intensive labor, a high degree of skill and craftsmanship, and lengthy times (1-2 days). Alternatively, a practitioner may opt for a sintered metal system that may be faster. However, those procedures are still labor intensive and complicated.

In recent years, technological advances have provided computer automated machinery capable of fabricating prostheses using minimal human labor and drastically lower work time. This is frequently referred to as "digital dentistry," where computer automation is combined with optics, digitizing equipment, CAD/CAM (computer-aided design/computer aided machining) and mechanical milling tools. Examples of such a computer-aided milling machine include the CEREC 2™ machine supplied by Siemens (available from Sirona Dental Systems; Bensheim, Germany) VITA CELAY™, (available from Vita Zahn Fabrik; Bad Sackingen, Germany) PRO-CAM™ (Intra-Tech Dental Products, Dallas, Tex.) and PROCERA ALLCERAM™ (available from Nobel Biocare USA, Inc.; Westmont, Ill.). U.S. Pat. Nos. 4,837,732, 4,575,805 and 4,776,704 also disclose the technology of computer-aided milling machines for making dental prostheses. These machines produce dental prostheses by cutting, milling, and grinding the near-exact shape and morphology of a required restorative with greater speed and lower labor requirements than conventional hand-made procedures.

Fabrication of a prostheses using a CAD/CAM device requires a "mill blank," a solid block of material from which the prosthetic is cut or carved. The mill blank is typically made of ceramic material. U.S. Pat. No. 4,615,678 discloses a blank adapted for use in machine fabrication of dental restorations comprising a ceramic silica material. There exist various mill blanks available commercially, including VITA CELAY™ porcelain blanks Vita Mark II Vitablocks™ and VITA IN-CERAM™ ceramic blanks (both available from Vita Zahn Fabrik; Bad Sackingen, Germany). Machinable micaceous ceramic blanks (e.g. Corning MACOR™ blanks and Dentsply DICOR™) are also known in the art.

SUMMARY OF THE INVENTION

The invention provides mill blanks for making dental prosthetics comprising a polymeric resin and a filler, wherein the mill blank is substantially free of cracks, or fissures, and able to withstand a Thermal Shock Test, a test that exposes the existence of internal stresses in the mill blank, which can lead to cracking of the material before or during the milling operation or during clinical use of the ultimate prosthesis. Preferably, the mill blank of the present invention is also substantially free of material discontinuities larger than about 1 millimeter. The mill blank's surprising ability to pass a Thermal Shock Test is a result of the relief of stress created during the curing process or proper low stress curing wherein little or no stress is actually created in the blank. Preferably low stress cure is performed by slow light curing methods. Heat treatment following a fast cure has also been surprisingly found to minimize internal stresses and provide the mill blank the same ability to pass the Thermal Shock Test.

By careful selection of the resin and filler, additional desirable material properties may be achieved, including superior cuttability and hardness over commercially available blanks Preferred resins are free radically curable, cationically curable, or a combination thereof. Preferred fillers for the invention are those that have been derived by sol-gel process.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side cross-sectional view of an exemplary embodiment of a mill blank and an exemplary embodiment of a mold for making the same.

FIG. **2** is a side cross-sectional view of an exemplary embodiment of a mill blank having a handle attached thereto.

DESCRIPTION OF THE INVENTION

Physical properties such as hardness and brittleness of ceramics limit the usefulness as dental prosthetics. Metals also have their shortcomings, as they are not aesthetic and may cause concern regarding allergic reactions and the like. Thus, it would be advantageous to have a prosthetic made from a strong and durable material, where the material would be suitable for use in simple and economical devices such as existing CAD/CAM manufacturing equipment.