

Melt etching improves
adhesion between resin
cement and zirconia

NIOM scientists develop new etching technique for zirconia ceramics – improves adhesion of resin cements

Ketil Kvam

Senior Engineer, Metallurgist M.Sc.



NIOM scientists have developed a surface etching technique that improves adhesion between resin cement and zirconia. Bond strength is increased by a factor of five over sandblasting according to a recent study in *Acta Biomaterialia Odontologica Scandinavica*. This new method called Melt Etching is based on melting of fluoride compounds, and can be readily adapted by dental technicians.

Chemically, zirconia is extremely stable and sandblasting crushes the surface. Both factors make it difficult to obtain long-lasting adhesion. Melt etching creates a rough surface with undercuts, which improves adhesion compared to surfaces treated by sandblasting (Figure 1).

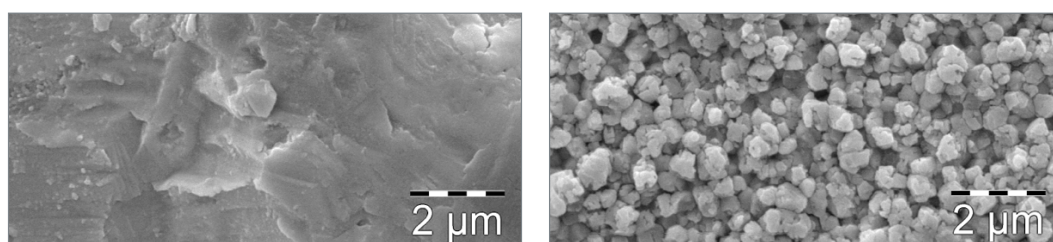


Figure 1. Scanning electron microscopy (SEM) images showing zirconia surfaces after different treatments; (a) sandblasted and (b) etched with potassium hydrogen difluoride.

Shear bond testing

Adhesive strength was measured by a shear bond test. The test measures the force needed to remove zirconia stubs cemented with resin to zirconia discs. The tests were performed on specimens that had been sandblasted or melt etched, with and without silanization of the zirconia surfaces. All etched specimens had higher shear bond strength than the sandblasted ones and significantly higher than the unsilanized, sandblasted specimens.

Melt etching method

After sintering, zirconia's phase structure consists of tetragonal crystals. The impulsive energy of sandblasting gradually changes the surface structure to unfavorable cubic or monoclinic phases. Melt etching limits structural changes because it is quick and the temperature remains low. This was confirmed by X-ray diffraction analyses. The changes in surface phase structure during melt etching are due to the removal of zirconium ions, as confirmed by Fourier Transform Infrared Spectroscopy (FT-IR) showing release of potassium hexafluorozirconate, $K_2[ZrF_6]$.

Clinical implications

- Zirconia has become a widely used as dental crown and bridge material thanks to its high strength and biocompatibility. Inferior bonding after cementation to implant abutments and prepared natural teeth has been a concern.
- The melt etch method is an easy method to improve adhesion.

The newsletter is based on the article:

Ruyter IR, Vajeeston N, Knarvang T, Kvam K: A novel etching technique for surface treatment of zirconia ceramics to improve adhesion of resin-based luting cements. *Acta Biomaterialia Odontologica Scandinavica*. 2017; 3(1): 36-46. <http://www.tandfonline.com/doi/full/10.1080/23337931.2017.1309658> (full-text available)

The zirconia phase
structure is not compromised
by melt etching

Standardization and Patient Safety – Ensuring that Dental Materials are Safe and Effective

Hilde M. Kopperud

Head of Laboratory, dr. scient.



Standardization ensures
product quality.

When considering patient safety, the quality and adequate function of a material or device is given by its mechanical strength, chemical stability and biocompatibility. Standards allow for ease of trade, since the product or service is well described, so that the manufacturer and the consumer have a common understanding of its expected performance.

It's all standards

When a medical device conforms to the appropriate ISO-standard, the dentist will know that the material, instrument or equipment complies with essential requirements of quality and function. Within the EU, the so-called harmonized standards are linked to the Medical Device Regulations, which specifies the requirements for attaining the CE-mark.

In practice, all technical components of a dental treatment are based on standards: the patient chair, the operation lamp, the rotating instruments, the sizes of burs, the restorative materials, the LED-lamp for curing, and the polishing tools. A practical example is the ease of attachment of a bur to a shaft due to standardization of the connections. Along with the ease of use by the dentist follows the fully secured attachment ensuring the safety of the patient during treatment.



NIOM participates in the technical committees ISO/TC 106 Dentistry and ISO/TC 194 Biological and clinical evaluation of medical devices.

Patient safety

Patient safety also includes biocompatibility. Methods for biological evaluations are covered by specific standards, e.g. ISO 7405 *Evaluation of biocompatibility of medical devices used in dentistry*. In addition, particular requirements are given in product standards. For instance, maximum fractions of hazardous elements, such as nickel and lead, are specified in the standard for metallic materials for fixed and removable restorations. Resistance of dental materials to fracture is also a matter of patient safety. ISO-standards for dental materials include requirements on the physical and mechanical properties of the material, especially their fracture strength.

NIOM participates in the technical committees ISO/TC 106 *Dentistry* and ISO/TC 194 *Biological and clinical evaluation of medical devices*. Our participation supports our vision: ensuring that dental materials are safe and effective. Many of the participants in the development of ISO-standards are manufacturers who may have commercial interests in the standardization of products. As a counterbalance, NIOM's participation supports the interests and safety of the patients.

The Digital Workflow

The development of new materials and digitalized preparation introduce challenges and the need for new standards as well as for revisions of existing standards. While the requirements for material properties may remain unchanged (because the clinical situation is similar), methods for preparing materials for testing and measurement techniques may need to be changed as technology advances. NIOM will continue to be the voice of the patients in the preparation of new standards, working to set requirements from the perspective of patient safety.



KNOWLEDGE – INNOVATION – QUALITY

The Nordic Institute of Dental Materials (NIOM) is responsible for promoting a continuing Nordic collaboration in the field of dental biomaterials. NIOM maintains a distinct Nordic profile through broad contacts with the Nordic dental educational institutions and research centres. The Institute undertakes research, materials testing, standardisation and research-based consulting directed towards health authorities and dental health services in the Nordic countries. Our research and consulting are required to be scientifically founded and applicable to clinical dentistry.

Patient safety includes
both biological and
mechanical properties of
dental materials.

Digital techniques and
modern materials introduce
challenges and the need
for new standards.

NIOM

Nordic Institute of
Dental Materials

Sognsveien 70A,

NO-0855 Oslo, Norway,

phone: (+47) 67 51 22 00

e-mail: niom@niom.no

www.niom.no