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# Effectiveness of protecting a zirconia bonding surface against contaminations using a newly developed protective lacquer

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ABSTRACT

*Objectives.* The purpose of this study was to test the effectiveness of a newly developed lacquer and its ability to protect pre-conditioned bonding surfaces of zirconia ceramic against contamination with saliva or silicone remnants.

*Methods.* Disk-shaped zirconia ceramic specimens were conditioned and cleaned using air-abrasion. Before contamination with saliva or silicone, a newly developed protective lacquer (1% ethyl cellulose in ethanol) was applied to the bonding surface. After contamination, all specimens of the test groups were cleaned in an ultrasonic bath filled with 99% ethanol for 3 min and then air-dried. A universal primer (Monobond Plus) was applied to the surfaces and then the specimens were bonded to composite resin filled acrylic tubes using a luting resin (Multilink Automix). Each group ($n = 16$) was divided into 2 subgroups ($n = 8$). One subgroup was stored for 3 days in 37 °C tap water and the other subgroup was stored for 150 days in 37 °C tap water interrupted by 37,500 thermal cycles between 5 °C and 55 °C. After the storage, the bond strength was measured using a material testing machine.

*Results.* The specimens of the test groups showed comparable bond strengths to the positive control group after short-term storage. After artificial aging, bond strengths of the test groups were statistically significantly lower compared to the positive control and were statistically significantly higher compared to the negative control groups.

*Significance.* Overall, the use of the newly developed protective lacquer appears to be a promising approach to protect pre-conditioned surfaces of zirconia ceramics against contamination.



## 1. Introduction

Adhesive cementation of all-ceramic zirconia based restorations is widely accepted for clinical use. Various clinical studies document the long-term success of bonded ceramic restorations, such as resin-bonded all-ceramic fixed dental prostheses and all-ceramic crowns [1–5].

For durable adhesive cementation, zirconia ceramic restorations need to be air-abraded (Fig. 1) [6–8]. When delivered already air-abraded by the dental technician, the ceramic

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surface might be contaminated by saliva, blood or silicone fit-indicators during clinical try-in procedures and the resulting residual organic and silicone contaminants may have a negative influence on the long-term bond strength and the longevity of the restoration, and need to be removed from the surface before cementation by using air-abrasion again [9–14]. Due to economic and practical considerations, using air-abrasion devices may not be widely accepted and therefore widespread in dental practices. Hence alternative cleaning methods like ethanol-irrigation or cleaning in an ultrasonic bath are often used by dentists. However, these alternative cleaning methods are not sufficient in removing the contaminations [10,12]. Therefore, the development of a new method to protect air-abraded zirconia ceramic bonding surfaces from contaminations using a protective coating appears to be an eligible attempt.

Ethyl cellulose is a derivative of cellulose in which some of the hydroxyl groups on the repeating glucose units are converted into ethyl ether groups. It is mainly used as a thin film coating material. Due to its chemical, biological and mechanical properties (insoluble in water, soluble in organic solvents, good biocompatibility and abrasion resistance), ethyl cellulose may be used as a protective coating for air-abraded zirconia ceramic bonding surfaces [15]. To the knowledge of the authors, no scientific data on the effectiveness of a protective coating for pre-conditioned ceramic bonding surfaces is available yet.

Therefore, the purpose of this in vitro study was to test the effectiveness of a newly developed lacquer and its ability to protect pre-conditioned bonding surfaces of zirconia ceramic from contamination by saliva or silicone. The study was designed to test the hypothesis, that an ethyl cellulose based protective coating has a positive influence on the bond strength of a bonding resin to zirconia ceramic after contamination.

## 2. Materials and methods

### 2.1. *Specimen preparation*

Disk-shaped specimens ($n = 256$) with a diameter of 7 mm and thickness of 3.4 mm were made of zirconia ceramic (Cerconbase, Degudent). All specimens were wet polished with rotating silicon carbide paper down to 600 grit and then air-abraded with 50 μm $Al_2O_3$ at 0.25 MPa pressure (Fig. 1). After air-abrasion, the average roughness was $R_a = 0.458$ μm as measured with a laser scanning microscope (VK-X100, Keyence).

### 2.2. *Lacquer application*

A protective lacquer using a solution of 1% ethyl cellulose in 99% ethanol was applied to the bonding surfaces of the specimens of the three test groups directly after air-abrasion, while negative controls and positive controls were not coated with the lacquer. After the ethanol had completely evaporated after 24 h of storage, the lacquer formed a thin and hard continuous coating on the bonding surface with an average thickness of approximately 20 μm as determined by scanning electron microscopy (Figs. 2 and 3).

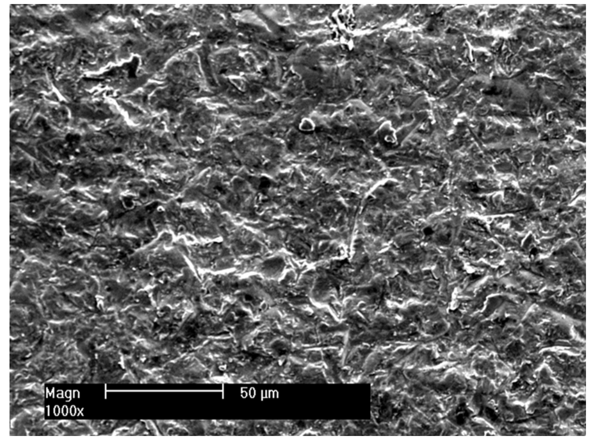


**Fig. 1 – Detailed magnification of a zirconia ceramic bonding surface after air-abrasion with 50 μm $Al_2O_3$. SEM: 1000× magnification.**

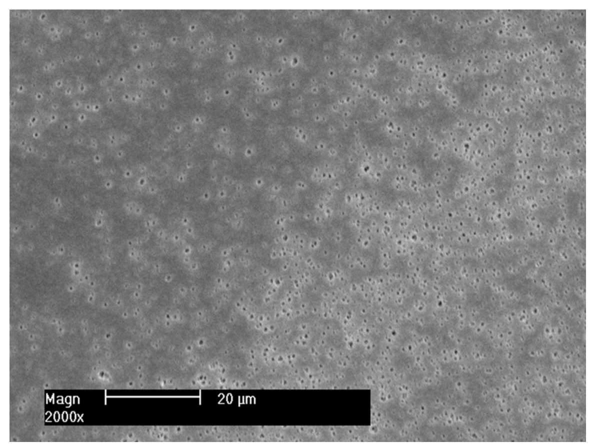


**Fig. 2 – Bonding surface of a zirconia ceramic coated with an ethyl cellulose-based protection lacquer. SEM: 2000× magnification.**

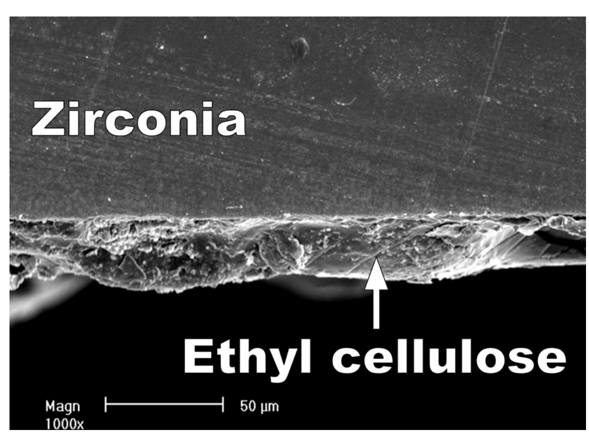


**Fig. 3 – Lacquer-coated specimen in cross section. Top of the figure: zirconia; center of the figure: ethyl cellulose based protection lacquer with an average thickness of approximately 20 μm. SEM: 1000× magnification.**