ESPE

Product Dossier

CoJet

ESPE

Table of Contents

1. Preface

Metal ceramic veneers are very important in dental medicine due to their great esthetics and stability in the mouth. Failures are observed primarily due to chipping of the veneer. The consequent removal and reworking of the restoration is difficult and cost-intensive. Intraoral repair with composite is indicated as an alternative but until now it has only been possible to achieve sufficient adhesion of the composite when the fracture is in the ceramic. There are currently still no repair systems available for repairs involving an exposed metal frameworks that can produce a permanent bond to metal intraorally.

The COJET system is a simple and safe method for the intraoral silicatization of metal restorations. COJET makes it possible to attach resins to ceramic and metal surfaces adhesively. In the case of large exposed metal surfaces, only intraoral silicatization with COJET gives clinically acceptable results.

2. Introduction

Dental materials research has produced a number of new materials in the area of tooth-colored restoration materials in the last thirty years. As a result of this development, a multiplicity of different materials are now available to the dentist. Added to this there is the growing demand by patients for esthetically impeccable work that is also affordable.

More and more importance is being given to the intraoral repair of ceramic or composite structures - especially in view of diminishing insurance benefits. Repair is therefore preferable in most cases to refabrication when defects with a small surface area are involved.

2.1 History

There have been repeated attempts in recent years to develop a simple, cost-effective and efficient intraoral repair system. In the case of adhesive attachment with repair composites, the technique of etching with hydrofluoric acid is currently used routinely. With small metal exposures, this method gives clinically acceptable results. But no additional adhesion to metal can be achieved in this way. In order to minimize the risk of failure, the etching technique should therefore only be used for ceramic repairs with no exposed metal.

Mechanical preparation of the fractured surface to produce a microretentive surface is an alternative to the problematic intraoral application of hydrofluoric acid.

2.2 Motivation

All the methods indicated above lead to rather unsatisfactory results, especially in cases with exposed metal surfaces. Moreover, the use of these repair systems is expensive and quite susceptible to error.

Recently, small sandblasters have been used increasingly to pretreat dental work. These sandblasters are already available in many dental offices, especially in the USA. With these devices, corundum particles (particle size varies from 50 to 250 mm depending on manufacturer) mechanically clean a surface and activate it by roughening (retentive surface). The best known example of these sandblasters is the Microetcher from the Danville Engineering Company.

Intraoral sandblasting with simultaneous silicatization of fractured surfaces using the ROCATEC method that has already been proven for many years leads to simplification of the repair process and to greatly improved results. With the development of COJET, ESPE has succeeded in applying the ROCATEC system best used in veneering technology to intraoral use. The surfaces pretreated with COJET allow an adhesive bond between composites and all conventional dental alloys or ceramic. Long years of experience in the dental office with the ROCATEC system confirm the reliability of the bond between the veneering material and the metal frame. Nevertheless, it was necessary to treat the ROCATEC sand for intraoral use because intraoral humidity is much higher than outside the mouth.

Combined with ESPE-SIL, VISIO-BOND and a composite (e.g. PERTAC II), permanent and cost-effective repairs can now be carried out in the patient's mouth with an application that is simpler than with the systems on the market up till now.

2.3 Indications

The COJET system can be used for the silicatization and repair of metal, ceramic and composite surfaces. COJET Sand used with ESPE-SIL is the foundation for chemical bonding with a bonding material and a composite. Due to its fine particle size (30 µm), the abrasion rate is much lower than with conventional abrasives. Even fine crown edges can therefore be treated with no damage.

The COJET system is suitable for the following areas of application:

- Pretreatment of metal restorations before adhesive luting with a composite luting cement
- Pretreatment of ceramic or composite restorations before adhesive attachment
- Repair of defective metal, ceramic and composite restorations

3. Chemical Background

3.1 General Overview

The COJET sand-blasting system consists of the actual coating medium (COJET Sand), the silane solution ESPE SIL, SINFONY Opaquer and the light-cured bonding material VISIO-BOND.

COJET Sand is a specially developed sand for coating all conventional dental materials intraorally such as, for example, metal, ceramic and composite surfaces. In addition to providing microretentive roughening, silicatized COJET Sand allows a ceramic-type coating of the surface of the material. Combined with ESPE SIL, the surface silicatized by COJET Sand provides the foundation for the adhesive bond. Long years of experience in the dental office with the ROCATEC method that is based on similar physical and chemical principles confirm that a permanent bond can be obtained between resin and the metal frame using surfaces coated in this manner.

Because of its fine particle size (30 μm), the abrasion rate is much lower than with conventional abrasives. Even fine crown edges can therefore be treated without damage.

3.2 Mechanism of Adhesion

The coating step during repair work is performed by sandblasting with silicatized COJET coating sand. Blasting causes the ceramic coating to be tribochemically anchored. Tribochemistry means the creation of a chemical bond by the use of mechanical energy. This energy can be supplied by rubbing, grinding or blasting.

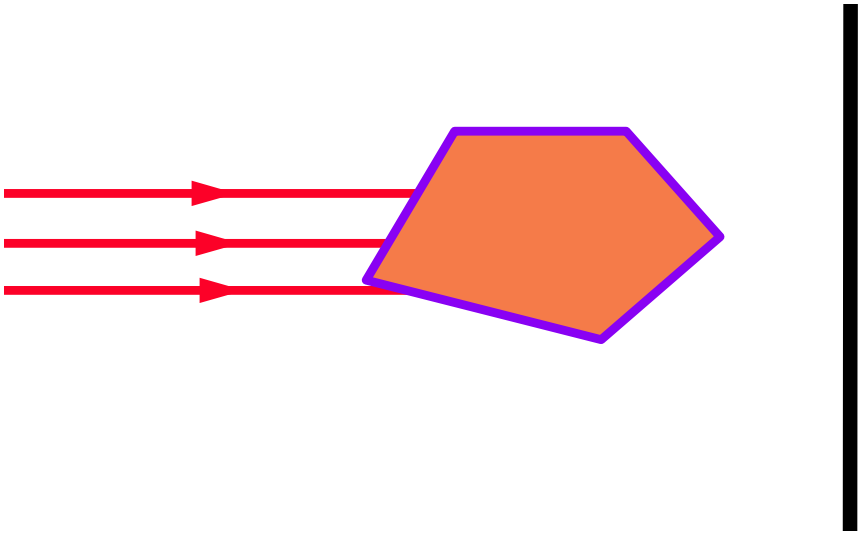

Figure 1: Tribochemical coating

If corundum particles, modified by silica, with a mean particle size of 30 μm strike the surface to be silicatized with great energy, very high temperatures are produced by the energy of impact (triboplasma). During this process, components of the blasting abrasive are incorporated into the metal down to a depth of 15 μm.

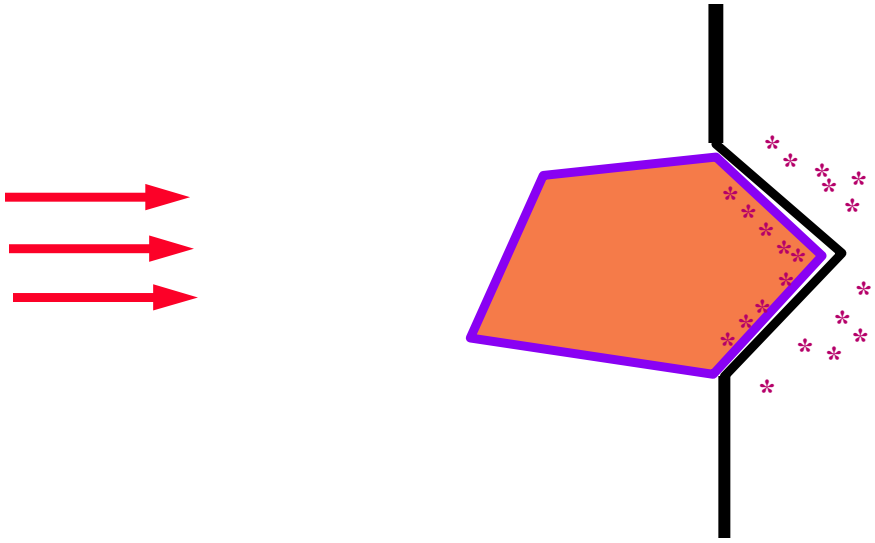

Figure 2: Tribochemical coating (impact)

Since this effect is limited to microscopically small areas of the surface, no temperature increase over the entire metal frame can be observed.

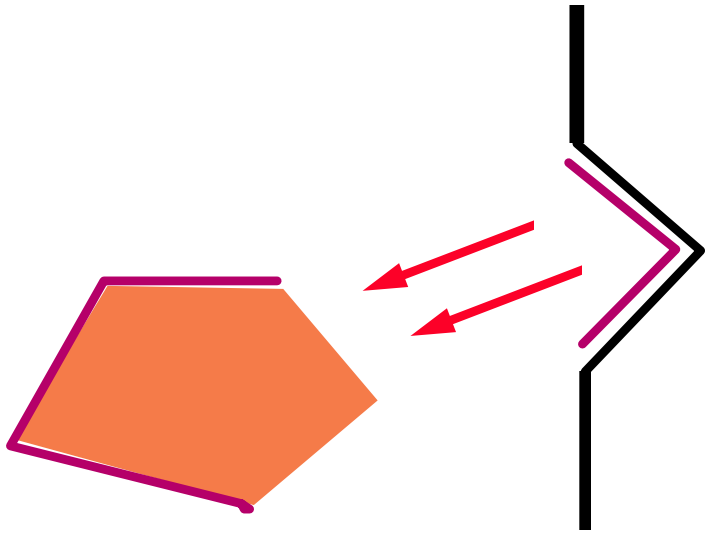

Figure 3: Tribochemical coating (silicatized metal surface)

The surfaces modified in this way are conditioned in the next step - silanization. Silanization with ESPE SIL first allows a chemical bond between the ceramic bonding agent layer and the opaquer or any other commercial methacrylated monomer system. The anchoring thus produced corresponds in broad outlines to the chemical binding of silanized fillers in the composite.

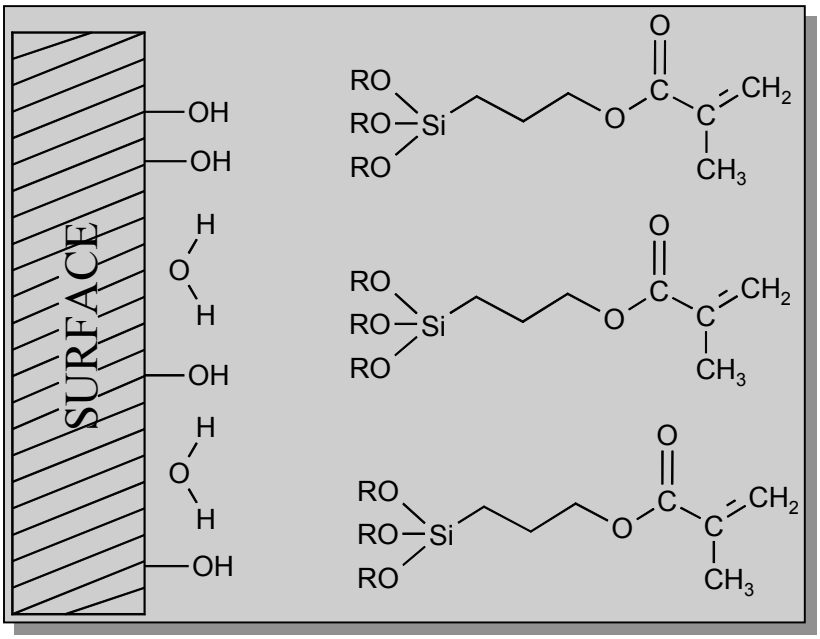

Figure 4: Silanization reaction

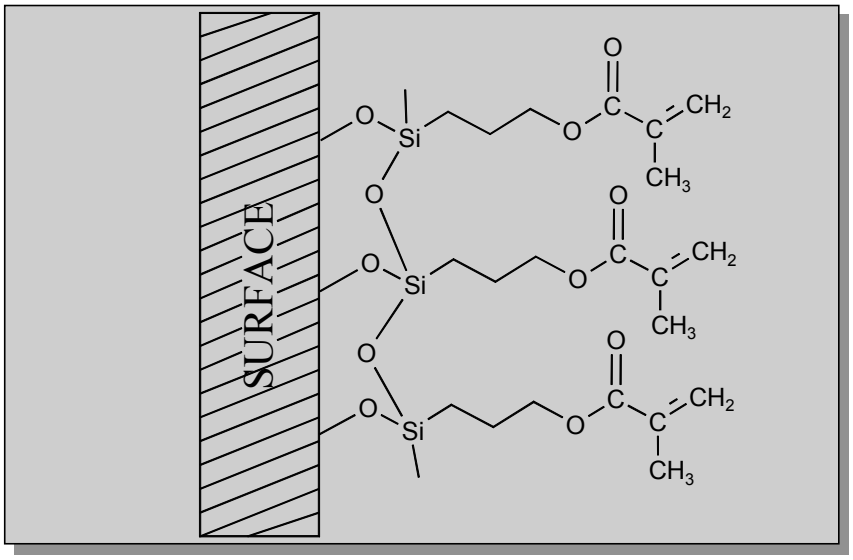

Figure 5: Silanization reaction

The silane used in ESPE SIL is distinguished by two different polar ends on the molecule. The alkoxy groups of the silanol unit, $(RO)_3Si$ group on the left side in Figure 4, form a chemical bond with the silicatized surface. The methacrylate groups (right side of the silane) can then be copolymerized with the monomers of the resin. In this way, a chemical bond is achieved between metal frame and resin.

In order to obtain an optimum, microgap-free bond to repair composites that are usually highly filled and therefore viscous, the next step has to be the application of VISIO-BOND to the previously silanized surface (Figure 5).

4. Composition of Product

4.1 Product Components

The COJET system is a collection of products for intraoral repair. The system consists of the following components:

- COJET Sand
  Coating abrasive for the cold silicatization of metal, ceramic and composite surfaces

- ESPE SIL
  Agent for silanizing silicatized surfaces

- VISIO-BOND
  Bonding agent for the repair composite used (e.g., PERTAC II)

- SINFONY Opaquer
  Covering for metal surfaces before the repair composite is layered on (e.g., PERTAC II)

4.2 Contents

The qualitative compositions of the components used in the COJET system are summarized in Tables 1a and 1b

CoJet® Sand	ESPE Sil®	Visio-Bond®
Silicatized sand (particle size 30 μm)	Silane	Bisacrylate
	Ethanol	Aminodiol methacrylate
		Camphor quinone
		Benzyl dimethyl ketale
		Stabilizers

Table 1a: Composition of CoJet, ESPE Sil and Visio-Bond

Powder	Liquid
Titanium dioxide	Methylmethacrylate
Calcium fluoride	Bifunctional acrylate
Silica gel	Copper chelate
Organic peroxide	Aminohydrochloride
Malonyl sulfamide	Phosphine oxide
Pigments	Copolymers

Table 1b: Composition of Sinfony Opaquer

5. Test Results

Good adhesion of the repair composite to a wide variety of dental materials is of crucial importance in intraoral repairs. A great number of adhesion tests have therefore been conducted which confirm the reliability of the method described above.

5.1 Adhesive Bond to Composite Materials

In a study at the University of Iowa, adhesion to PERTAC HYBRID test pieces was tested following different surface treatments. The result of this test is given in Figure 6.

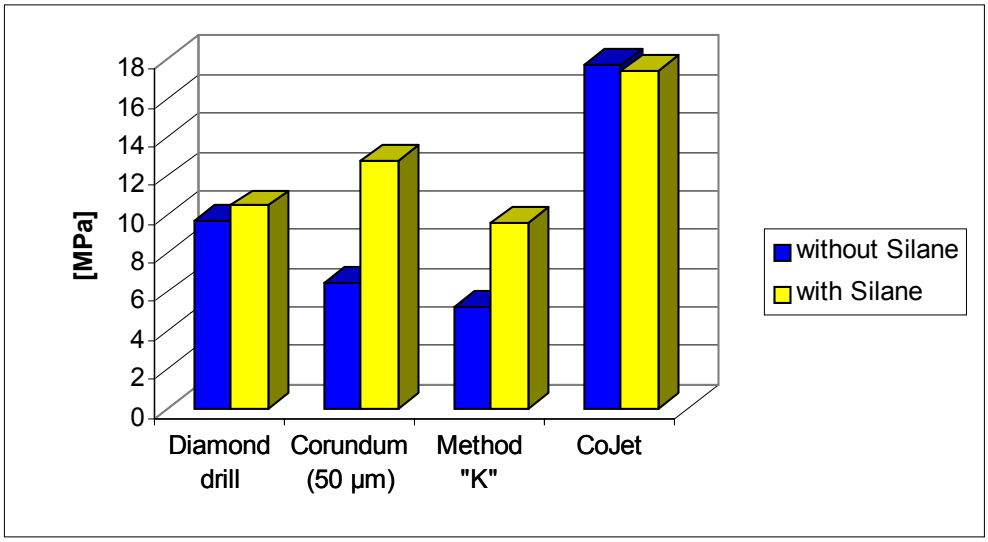

Figure 6: Adhesion to composites (M.R. Bouschlicher et. al., University of Iowa)

COJET exhibits significantly greater adhesive values than the other pretreatment methods. The application of the COJET system is a substantial improvement in the bonding of an ”old” composite structure to repair composite.

Expulsion tests of pretreated composite inlays conducted at the University of Erlangen came to similar clinical conclusions. Here too the best adhesive values were obtained for composite structures pretreated with COJET and silane.

5.2 Adhesive Bond to Metals

As already pointed out in the introduction, the permanently stable bonding of composite materials to metal surfaces is a very important requirement of all conditioning procedures. Shear tests of adhesion on variously pretreated metal surfaces (semi-precious alloys) with and without silane as a bonding agent showed much better values for COJET than for pretreatment with high-speed diamonds, blasting with 50 μm corundum particles or airblast roughening.

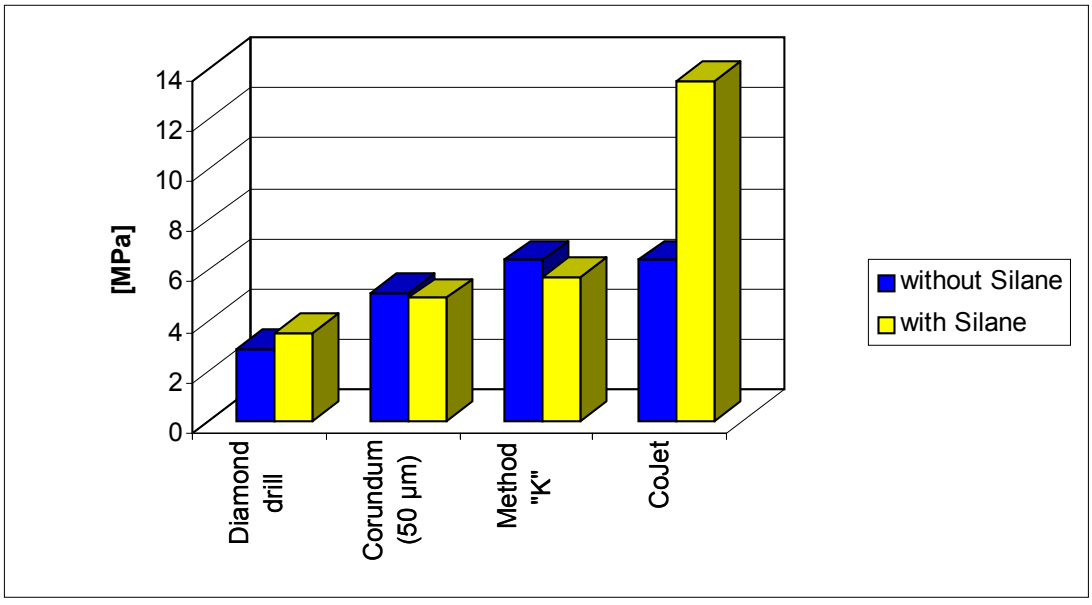

Figure 7: Adhesion to metal surfaces (M.A. Vargas et. al., University of Iowa)

5.3 Adhesive Bond to Ceramic

The surface conditioning systems tested were applied to cylindrical porcelain test pieces. After surface treatment, some of the test pieces were etched with 32% phosphoric acid and the others were etched with 4% hydrofluoric acid. In another shear test for adhesion, no acid etching was performed in the case of COJET. A shear adhesion test was performed in which all test pieces were kept for one week in 37°C distilled water and then subjected to 300 thermocycles. The results of the study are shown in Figure 8.

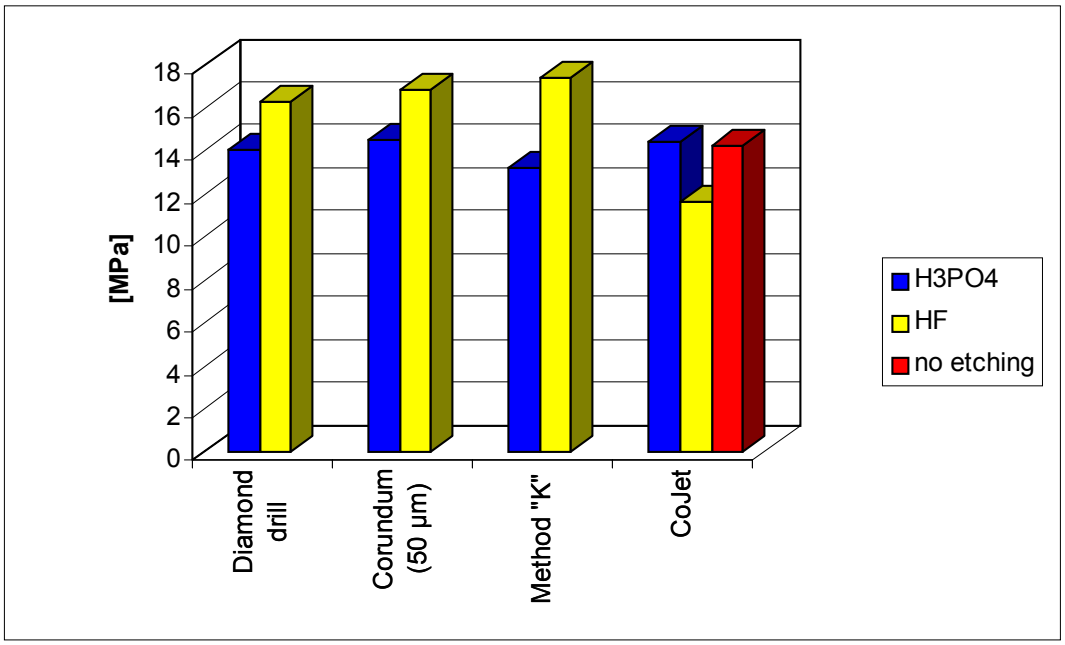

Figure 8 Adhesion to ceramic (D. Boyer et. al., University of Iowa)

It turns out that when a test piece pretreated with COJET was etched with hydrofluoric acid, the adhesive bond was much lower than in the case of etching with phosphoric acid. This can be attributed to the fact that the hydrofluoric acid reacts chemically with the silicatized metal surface and destroys it. Comparison with the adhesive values of the unetched surface makes it clear that the application of COJET alone leads to equally good results. In this case, acid etching with phosphoric acid is not needed.

5.4 Adhesion of Composite to PMF Ceramic with an Exposed Metal Frame

The purpose of this study conducted at the University of Erlangen was to determine the adhesive strength of composites to a veneering ceramic with varying metal exposure. Clinically acceptable values could only be achieved with the etching technique when the metal percentage was <35%. By contrast, even greater adhesive values were obtained with the COJET system for metal exposures of 50% than on ceramic alone. Because of its very good adhesion both to metal and to ceramic, COJET is currently the only method with which it is possible to achieve clinically acceptable repair composite shear strength.

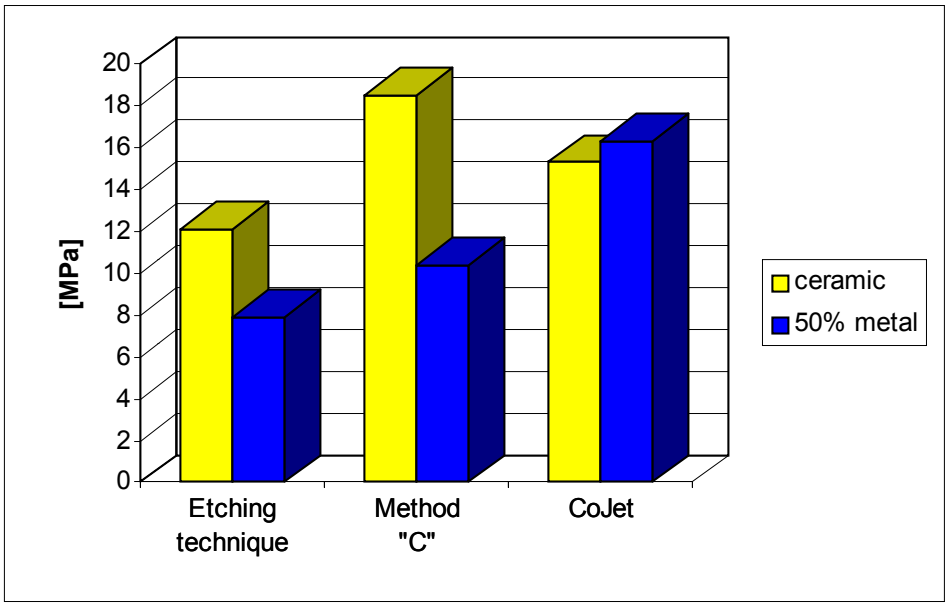

Figure 9: Adhesion to PMF ceramic with exposed metal frame (J. Sindel et. al., University of Erlangen)

5.5 Dust in Ambient Air

Apart from good adhesion of the repair composite to widely varied dental materials, the toxicological safety of the steel medium used is of crucial importance. In a study conducted by Prof. Niedermeier at the University of Cologne, the effect of dust in the ambient air was tested with SiO_2 and Al_2O_3 particles. Dust particles with a particle size <5 µm were of the greatest interest since the greatest risk potential is assumed to be for these particles. This study showed that both SiO_2 and Al_2O_3 concentrations were clearly within the internationally recognized limits.

The results were presented at the IADR/CED meeting in Madrid (September 1997). Prof. Niedermeier summarized his results as follows:

> ” ... It can be concluded that concern regarding the risk of oral tribochemical methods and possible damage to the health of patients an dental stuff [sic] is unfounded. Under normal conditions and even without protective measures, the concentration in air of harmful SiO_2 dust particles are far below the current threshold value of 15 µg/m3.”

6. Summary

The development of the COJET system gives the dentist an effective aid in the repair of indirect restorations and fillings. Surfaces of a great variety of dental materials pretreated with COJET exhibit consistently outstanding adhesive values compared with repair composites. COJET is currently the only system of all the repair systems on the market that allows clinically acceptable bonding both to metal and to ceramic surfaces. It is therefore ideal for the repair of veneers with exposed metal surfaces.

Its great adhesive values and long years of experience with the ROCATEC system in other areas of dentistry make COJET a universal repair system.

The application of COJET also substantially improves the composite inlay/attachment composite bond.

7. Directions for Use

Preparation

- Always place a rubber dam in the patient's mouth when using COJET Sand.
- The wearing of safety glasses is recommended for both patient and dentist.
- Contamination of the silicatized layer, e.g., with saliva, causes the adhesive bond to deteriorate.

Repair of Defects in Ceramic

Coat with COJET Sand:

- Load COJET Sand into an intraoral blaster. The container must be clean and dry. Blasting pressure 2 to 3 bar (30 to 42 psi).
- Check operation on a metal strip, over the washbasin for example. With sufficient pressure, the metal turns a uniformly dark color.
- Coat the part of the ceramic to be repaired evenly. Blasting time is approx. 15 seconds for a veneer facing and correspondingly shorter for smaller areas.

Silanize with ESPE SIL:

- Then moisten the coated area directly with ESPE SIL. Measure out ESPE SIL into a Dappen dish, apply with a brush and allow to dry for 30 seconds.

Bond with VISIO-BOND:

- Dispense VISIO-BOND onto a block and apply a thin layer to the silanized area with a disposable brush.
- Light-cure for 20 seconds per facing area.
  VISIO-BOND is matched for adhesive bonding with ESPE SIL. Do not use bonding material from any other system! VISIO-BOND is compatible with all commercial composites.

Complete with composite:

- Select a suitable shade and dispense the amount needed onto a block.
- Apply the composite to the prepared ceramic surface and shape with a suitable instrument (comply with the layer thickness and polymerization times of the particular material).
- Light-cure the composite. In the case of thicker layers, shape several layers as necessary and polymerize each separately.
- Finish with fine-cut diamonds and polish with polishing paste.

Repair of Defects in Ceramic with Exposed Metal

The decision to make an intraoral repair should always be based on the determination that the configuration of the underlying metal structure is correct and is not the actual cause of the ceramic fracture.

Coat with COJET Sand:

- Load COJET Sand into an intraoral blaster. The container must be clean and dry. Blasting pressure 2 to 3 bar (30 to 42 psi).
- Check operation on a metal strip, over the washbasin for example. With sufficient pressure, the metal turns a uniformly dark color.
- Coat the exposed metal and part of the ceramic to be repaired evenly. Blasting time is approx. 15 seconds for a veneer facing and correspondingly shorter for smaller areas.

  Metal is sufficiently coated when it has turned a uniformly dark colour.
  Observe the correct blasting time for ceramic.

Silanize with ESPE SIL:

- Then moisten the coated area directly with ESPE SIL. Measure out ESPE SIL into a Dappen dish, apply with a brush and allow to dry for 30 seconds.

Cover the metal with SINFONY Opaquer:

- Measure out the powder and liquid of the desired SINFONY Opaquer colour in a 1:1 ratio into a Dappen dish and stir to a creamy consistency with a plastic spatula. Mixing time 45 seconds.
- Apply the mixed opaquer in a thin layer on the surface of the metal, but not on the ceramic, with a clean fine brush. SINFONY Opaquer covers in a layer of 0.1 mm. Handling time is 5 minutes.
- Light-cure for 10 seconds (e.g., with the ESPE ELIPAR light unit).

Treat ceramic with VISIO-BOND:

- Dispense VISIO-BOND onto a block and apply a thin layer to the silanized ceramic with a disposable brush. Moistening the opaquer with the bonding material is not necessary but also not harmful.
- Light-cure for 20 seconds per facing area.
- VISIO-BOND is matched for adhesive bonding with ESPE SIL. Do not use bonding material from any other system! VISIO-BOND is compatible with all commercial composites.

Complete with composite:

- Select a suitable shade and dispense the amount needed onto a block.
- Apply the composite to the prepared ceramic surface and shape with a suitable instrument (comply with the layer thickness and polymerization times of the particular material).
- Light-cure the composite. In the case of thicker layers, shape several layers as necessary and polymerize each separately.
- Finish with fine-cut diamonds and polish with polishing paste.

Repair of Defects in Composite

Prepare composite surface:

- Roughen the composite surface with an abrading instrument, clean off with a water spray and air-dry.

Coat with COJET Sand:

- Load COJET Sand into an intraoral blaster. The container must be clean and dry. Blasting pressure 2 to 3 bar (30 to 42 psi).
- Check operation on a metal strip, over the washbasin for example. With sufficient pressure, the metal turns a uniformly dark color.
- Coat the area to be later covered with composite evenly. Blasting time is approx. 15 seconds for a veneer facing and correspondingly shorter for smaller areas.

Silanize with ESPE SIL:

- Then moisten the coated area directly with ESPE SIL. Measure out ESPE SIL into a Dappen dish, apply with a brush and allow to dry for 30 seconds.

Bond with VISIO-BOND:

- Dispense VISIO-BOND onto a block and apply a thin layer to the silanized area with a disposable brush.
- Light-cure for 20 seconds per facing area.
- VISIO-BOND is matched for adhesive bonding with ESPE SIL. Do not use bonding material from any other system! VISIO-BOND is compatible with all commercial composites.

Complete with composite:

- Select a suitable shade and dispense the amount needed onto a block.
- Apply the composite to the prepared ceramic surface and shape with a suitable instrument (comply with the layer thickness and polymerization times of the particular material).
- Light-cure the composite. In the case of thicker layers, shape several layers as necessary and polymerize each separately.
- Finish with fine-cut diamonds and polish with polishing paste.

Repair of Defects in Composite with Exposed Metal

Prepare composite surface:

- Roughen the composite surface with an abrading instrument, clean off with a water spray and air-dry.

Coat with COJET Sand:

- Load COJET Sand into an intraoral blaster. The container must be clean and dry. Blasting pressure 2 to 3 bar (30 to 42 psi).
- Check operation on a metal strip, over the washbasin for example. With sufficient pressure, the metal turns a uniformly dark color.
- Coat the exposed metal and the area to be later covered with composite evenly. Blasting time is approx. 15 seconds for a veneer facing and correspondingly shorter for smaller areas.

  Metal is sufficiently coated when it has turned a uniformly dark color.
  Observe the correct blasting time for composite.

Silanize with ESPE SIL:

- Then moisten the coated area directly with ESPE SIL. Measure out ESPE SIL into a Dappen dish, apply with a brush and allow to dry for 30 seconds.

Cover the metal with SINFONY Opaquer:

- Measure out the powder and liquid of the desired SINFONY Opaquer colour in a 1:1 ratio into a Dappen dish and stir to a creamy consistency with a plastic spatula. Mixing time 45 seconds.
- Apply the mixed opaquer in a thin layer on the surface of the metal, but not on the composite, with a clean fine brush. SINFONY Opaquer covers in a layer of 0.1 mm. Handling time is 5 minutes.
- Light-cure for 10 seconds.

Bond with VISIO-BOND:

- Dispense VISIO-BOND onto a block and apply a thin layer to the silanized composite with a disposable brush. Moistening the opaquer with bonding material is not necessary but also not harmful.
- Light-cure for 20 seconds per facing area.
- VISIO-BOND is matched for adhesive bonding with ESPE SIL. Do not use bonding material from any other system! VISIO-BOND is compatible with all commercial composites.

Complete with composite:

- Select a suitable shade and dispense the amount needed onto a block.
- Apply the composite and shape with a suitable instrument (comply with the layer thickness and polymerization times of the particular material).
- Light-cure the composite. In the case of thicker layers, shape several layers as necessary and polymerize each separately.
- Finish with fine-cut diamonds and polish with polishing paste.

Pretreatment of Metal, Ceramic or Composite Restorations before Cementing

Coat with COJET Sand:

- Load COJET Sand into an intraoral blaster. The container must be clean and dry. Blasting pressure 2 to 3 bar (30 to 42 psi).
- Check operation on a metal strip, over the washbasin for example. With sufficient pressure, the metal turns a uniformly dark color.
- Coat the exposed metal, ceramic or composite area evenly. Blasting time is approx. 15 seconds for a veneer facing and correspondingly shorter for smaller areas.

  Metal is sufficiently coated when it has turned a uniformly dark color.
  Observe the correct blasting time for composite.

Silanize with ESPE SIL:

- Then moisten the coated area directly with ESPE SIL. Measure out ESPE SIL into a Dappen dish, apply with a brush and allow to dry for 30 seconds.

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