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Adhesion between lithium disilicate and veneering porcelain: *The role of the interlayer glaze in preventing delamination failure.*

Adhesion between lithium disilicate and covering porcelain: The role of the glaze interlayer in the prevention of delamination failures

Adhesion between the lithium disilicate and the porcelain that covers it: the paper of the layer interspersed in the prevention of delamination failures

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Abstract. Delamination of veneering porcelain over lithium disilicate substructures is a one of the most frequent technical failures in bilaminate ceramic restorations. Although the IPS system e.max presents high survival rates in long-term clinical follow-ups, the The interface between the disilicate substrate and the layering ceramic remains a vulnerable point. This article analyzes what happens when layer-to-layer adhesion protocols are not strictly observed. the adhesion mechanisms between lithium disilicate and the veneering porcelains of the IPS e.max system Ceram discusses the factors that contribute to delamination failure and presents the protocol for Intermediate glaze layer as a preventive approach. The analysis is based on a review. narrative of the literature and the authors' laboratory experience in the systematic application of this technique. throughout more than two decades of working with dental ceramics.

Keywords: lithium disilicate; IPS e.max Ceram; delamination; ceramic adhesion; glaze intermediate; stratification.

Abstract. Delamination of veneering porcelain over lithium disilicate frameworks represents one of the most frequent technical failures in bilayered ceramic restorations. Although the IPS e.max system exhibits high survival rates in long-term clinical follow-ups, the interface between the disilicate substrate and the layering ceramic remains a vulnerable point when interlayer adhesion protocols are not rigorously adhered to. This article analyzes the adhesion mechanisms between lithium disilicate and IPS e.max Ceram veneering porcelains, discusses factors contributing to delamination failure, and presents the intermediate glaze-layer protocol as a preventive approach. The analysis is based on a narrative literature review and on the authors' laboratory experience in the systematic application of This technique over more than two decades of work with dental ceramics.

Keywords: lithium disilicate; IPS e.max Ceram; delamination; ceramic adhesion; intermediate glaze; layering.

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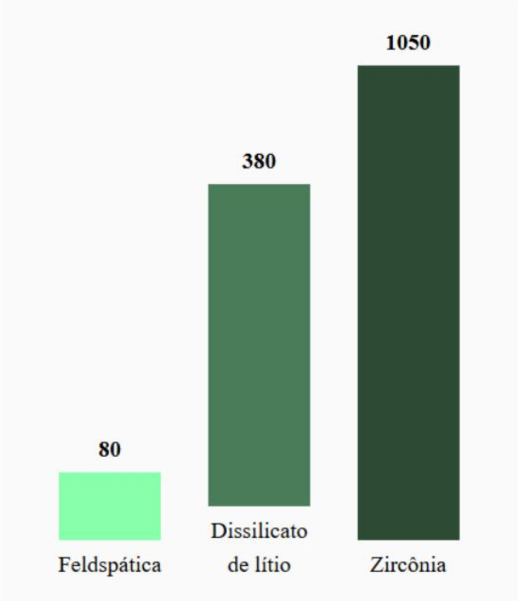
1. The clinical problem: delamination in bilaminate restorations

Bilaminate ceramic restorations occupy a consolidated position in aesthetic rehabilitation. contemporary. The principle is well-known: a high mechanical strength infrastructure receives Porcelain veneers that replicate the optical characteristics of a natural tooth. Lithium disilicate, in the form of the IPS e.max Press and IPS e.max CAD systems, has become the substrate for reference for this application in anterior restorations, combining flexural strength in the range 360 to 400 MPa with translucency compatible with enamel mimicry. Follow-up clinical studies report high survival rates for single crowns in Stratified lithium disilicate, with values close to 98% over 11 years. The technical failure. The most documented issue in this type of restoration, however, is chipping or delamination of the ceramic. coverage. The prevalence of chipping in bilaminate restorations reported in the literature varies. It varies depending on the system, the type of restoration, and the observation period, but the numbers are consistent. by indicating this flaw as the predominant technical complication.

Figure 1. Comparative flexural strength between the main ceramic systems used in aesthetic restorations (average values in MPa).



Source: data compiled from Gracis et al. (2015), Höland et al. (2000) and Ivoclar Vivadent AG (2011). Values represent average bending strength. biaxial under standardized laboratory conditions.

The graph alongside illustrates the position of lithium disilicate in Resistance spectrum of ceramic materials. A intermediate strength between feldspathic ceramic and Zirconia is precisely what makes disilicate suitable. for layered restorations: it offers support sufficient mechanical properties for the porcelain veneer and, at the same time time allows for optical behavior compatible with The natural aesthetic. The challenge lies in the interface between these two materials.

Santos (2026), in his work on adhesion and stratification protocols with the IPS e.max system, It highlights that the major innovation in preventing delamination consists of applying a layer. of Glase Powder or Glase Paste E.max Ceram before conventional layering, and warns that this This procedure should not be replaced by the application of Glase Ivocolor IPS E.max Ceram, which does not...

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It promotes adhesion and can cause blistering during subsequent burns. This Observation, derived from years of systematic laboratory practice, points to an aspect of the protocol. which the scientific literature has not yet explored with the depth it deserves.

2. Adhesion mechanisms at the disilicate/porcelain veneer interface

The adhesion between a lithium disilicate infrastructure and the veneering porcelain depends on three Mechanisms that act simultaneously: chemical adhesion, mechanical adhesion, and compatibility of coefficients of thermal expansion. When the three mechanisms operate in equilibrium, the interface It withstands the stresses generated during the burning, cooling, and chewing cycles. When any of them fail, the interface becomes the weak point of the restoration process.

Chemical adhesion occurs through the formation of bonds between the vitreous components of the porcelain. The interaction between the coating and the surface of the disilicate substrate depends on the temperature of the coating. The combustion process depends on the time spent at the thermal plateau and the composition of both materials. Lithium disilicate is a glass-ceramic that features a crystalline phase dispersed in a glassy matrix. IPS e.max Ceram veneering porcelain, in turn, is a low-fusing feldspathic ceramic. Developed specifically for compatibility with the IPS e.max substrate. The chemical interaction The energy transfer between these two surfaces occurs preferentially in the glassy phase of the substrate, where the energy The superficial surface facilitates wetting by the fused porcelain.

Mechanical adhesion results from the penetration of fused porcelain into the surface irregularities of the substrate. When the disilicate infrastructure is sprayed with fine-particle aluminum oxide. or treated with hydrofluoric acid, the surface acquires micro-roughness, which favors anchoring. Mechanical. This mechanism complements chemical adhesion, but depends on proper preparation of the surface before stratification.

The compatibility of the coefficients of thermal expansion (CTE) is the third determining factor. The cation exchange capacity (CEC) of lithium disilicate is around 10.2 x 10ÿÿ/K, and the CEC of IPS e.max Ceram porcelain... is slightly lower, in the range of 9.5 x 10ÿÿ/K. This controlled difference causes the porcelain to The coating remains slightly compressed after cooling, which promotes the resistance of the interface. When this difference is very large or when cooling occurs in a way excessively fast, residual stresses accumulate at the interface and favor the propagation of cracks.

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3. Factors that contribute to delamination failure

The delamination of porcelain on lithium disilicate is a multifactorial phenomenon. The literature identifies at least five main factors that, alone or in combination, increase the risk of this failure.

The first factor is the lack of proper surface treatment of the infrastructure before... application of porcelain. When the disilicate substrate is layered without surface preparation, the Adhesion depends exclusively on chemical interaction, which may be insufficient to resist the... Mechanical and thermal stresses accumulated over clinical use. Surface preparation, with Controlled blasting and the application of wetting agents is a fundamental step. which does not always receive the attention it deserves in the laboratory workflow.

The second factor is the incompatibility between the materials of the infrastructure and the roofing. Each The ceramic system is designed to work with specific veneer porcelains, whose CETs They were calibrated for this combination. The use of porcelains from different systems or of Products with incompatible compositions alter the stress balance at the interface and increase the risk. adhesive failure.

The third factor involves the combustion parameters. Temperatures above or below the recommended level, Inadequate lifting speeds and incorrect dwell times can compromise the Chemical interaction between the layers. The excess of firing cycles, common in cases that require Successive color or shape corrections also degrade the interface through the accumulation of stress. residual thermals.

The fourth factor is the thickness control of the infrastructure and porcelain layers. Santos (2026) emphasizes that repairs to infrastructure should be carried out using specific tools for lithium disilicate, using reduced rotation, of a maximum of 15,000 rpm, to avoid the Localized overheating, which can alter the surface microstructure and compromise adhesion. to the porcelain applied subsequently. The technique of applying a colored wax-tipped pencil to the face. The internal structure of the infrastructure, as described by the author, allows for visual monitoring of thickness during wear. and prevents excessive reductions that compromise the overall strength.

The fifth factor is the cooling protocol after each firing cycle. Rapid cooling generates Thermal gradients between the surface and the interior of the part, producing tensile residual stresses in the interface that can initiate cracks invisible to the naked eye. These microcracks remain latent until that the masticatory load propagates them, resulting in clinical delamination months or years after the installation.

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4. The intermediate glaze layer as a preventive protocol

The application of a glaze layer between the disilicate substructure and the layering porcelain. This constitutes the central contribution that this article proposes to discuss. This approach, systematized in The authors' laboratory experience, gained over years of application, acts on the adhesion mechanism. chemistry at the interface, creating a transition zone between the crystalline substrate of the disilicate and the porcelain roofing material.

The protocol consists of applying a thin, even layer of Glaze Powder or Glaze Paste. IPS e.max Ceram over the entire surface of the infrastructure that will receive the layering. This layer It is then subjected to firing with specific parameters: 5-minute drying time, temperature increase of 55 °C per minute. and a final temperature of 830 °C, held for 1 minute and 30 seconds. During the burning process, the The glaze material melts and interacts with the vitreous phase of the disilicate surface, forming a An intermediate layer of gradient composition that facilitates the transition between the two.

This intermediate layer performs three functions at the interface. The first is to promote wetting. The top surface of the disilicate is covered by the porcelain veneer applied in the next step. Fused porcelain encounters a surface with a more compatible vitreous composition, which increases the effective contact area and, consequently, the strength of the joint. The second function is to fill microporosities and irregularities on the substrate surface that could act as Stress concentrators and crack initiation points. The third function is to create a transition zone. CET between the substrate and the covering, attenuating the residual thermal stress gradient.

During the glaze firing stage, the authors recommend the simultaneous creation of the mamelons. The internal layers of the stratification. Dentin mamelons are applied over the glaze layer that has not yet formed. burned and taken to the burning simultaneously. This procedure allows the mamelons to be integrated into Glazing in a single firing reinforces the adhesion between the first layers of the effect and the substrate.

Conventional layering with IPS e.max Ceram opalescent masses follows next, with Burning and drying parameters of 5 minutes, temperature rise of 55 °C per minute and final temperature of 780 °C, held for 1 minute and 30 seconds.

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Table 1. Comparison between protocols with and without an intermediate glaze layer in stratification on lithium disilicate.

Feature	Protocol without glaze intermediary	Protocol with glaze intermediate (Glaze E.max Ceram)
Wetting from the surface made of porcelain coverage	It depends on surface energy. of disilicate after preparation mechanic	Increased by the presence of compatible vitreous layer
Chemical adhesion in interface	Interaction direct disilicate/feldspathic porcelain	Interaction mediated by layer of transition with composition gradient
Microporosity in substrate surface	They remain as voltage concentrators	Filled with molten glaze during the burning
CET gradient in interface	Direct transition between CET of porcelain disilicate and CTE	Gradient attenuated by the layer intermediate
Risk of delamination	Present, especially in restorations subjected to loads cyclical	Reduced by improvements in the three adhesion mechanisms
Additional steps in laboratory workflow	None	An additional burn (glaze + mamelos)

5. Differentiation between glaze materials: a relevant laboratory observation

One aspect that deserves special attention and that the literature published to date does not address is... The systematic difference lies in the performance of the glaze materials available on the market. for use with the IPS e.max system. Santos (2026), based on experience accumulated over With over 27 years of laboratory practice, it is noted that the intermediate layer protocol should be... executed exclusively with Glaze Powder or Glaze Paste from the IPS e.max Ceram line, and not with Ivocolor product line.

Glase Ivocolor IPS e.max Ceram, although indicated for surface finishing and characterization

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e.Max IPS restorations have a composition and thermal behavior distinct from other systems. e.max Ceram Glaze line materials. When used as an intermediate layer before In terms of stratification, Ivocolor does not promote the same degree of chemical interaction with the surface of disilicate. In the authors' experience, the use of this material in the intermediate glaze stage... resulted in the formation of bubbles during subsequent stratification burns, compromising both the adhesion between the layers and the final aesthetics of the restoration.

This difference in behavior can be attributed to differences in the composition of the fluxes and in the The melting points of the two materials. The Glaze from the é.max Ceram line was formulated to interact with the disilicate surface at temperatures compatible with the washbake protocol, while the Ivocolor has been optimized for application on already laminated ceramics at lower temperatures. Replacing one material with another alters the thermal and chemical equilibrium of the interface.

This technical observation, first explicitly recorded in the work of Santos (2026), has This has direct practical implications for routine laboratory work. Inadequate selection of glaze material can... compromising the entire stratification protocol, negating the adherence gains that the layer The intermediary aims to provide this information. Disseminating this information among professionals in Laboratory and clinical prescription of layered restorations is a necessary step to reduce the incidence of delamination failures.

6. Implications for the complete laboratory protocol

The incorporation of the intermediate glaze layer into the layering flow on lithium disilicate. This implies a reorganization of the laboratory protocol. The conventional workflow, which starts from Infrastructure prepared directly for the application of ceramic masses now includes a step... An intermediate burning stage, which delays the process, is justified by the improvement in the quality of the... interface.

The complete laboratory protocol, as practiced by the authors, follows the sequence below. A Disilicate infrastructure is manufactured by injection molding or milling. After exclusion or removal From the sprues, the contacts are adjusted and controlled reduction is performed, creating space for the layers. Made of porcelain. The wear processes follow strict rotation and instrumentation parameters, according to described in the section on failure factors. The surface is then cleaned and prepared to receive the coating. glaze.

Apply a layer of Glaze Powder or Glaze Paste IPS e.max Ceram to the entire area that will receive the coating. stratification. The inner mamelons of dentin are positioned over the glaze layer, and the The mixture is subjected to a washbake firing at 900 °C. After this firing, the stratification

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The conventional approach continues with opalescent and effect masses, selected according to the final color. desired. Conventional stratification firing occurs at 780 °C. Instrument finishing Sequential abrasives and the final characterization glaze conclude the process, with firing at 750 °C. Adding a burn to the protocol implies an investment of 30 to 40 minutes, considering the Oven cycle and handling time. This investment is offset by the reduction in rework resulting from delamination, which requires the complete removal of the ceramic covering and The re-stratification of the part, with significantly higher time and material costs.

Collaboration between the laboratory and the clinic is a relevant component in the implementation of this. protocol. The clinician who understands the importance of the intermediate layer can plan the case. considering the additional manufacturing time and informing the patient, when necessary, that the The laboratory protocol adopted prioritizes the longevity of the restoration. This communication between the Professionals involved in the rehabilitation chain strengthen the predictability of results and reduce the risk. probability of dissatisfaction with the clinical performance of the part.

7. Perspectives and gaps in the literature

A review of the available literature on the adhesion between lithium disilicate and veneering porcelains. reveals a significant concentration of studies focused on the zirconia/porcelain interface, where the Delamination is more frequent and more severe. The disilicate/feldspathic porcelain interface has received... comparatively lower attention, possibly because the survival rates of the IPS e.max system The expectations are high, and the problem is perceived as less urgent. This perception, however, is not... This corresponds to everyday laboratory experience, in which delamination remains an occurrence. relevant.

There is a specific gap in the literature regarding the use of intermediate glaze layers. as a protocol for preventing delamination in layered disilicate restorations. The practice The method described in this article is adopted by experienced ceramic technicians in various laboratories of Reference, but formal documentation of this technique in scientific publications remains scarce. This gap limits the ability of new professionals to access the protocol through the available channels. Formal training and research.

Laboratory studies evaluating the bond strength between lithium disilicate and porcelain. Comparing samples with and without an interlayer glaze would be a valuable contribution. valuable for validating this technique. Shear, microtensile, or bending tests on samples. bilaminate layers could quantify the adhesion gain provided by the intermediate layer and to provide numerical data that complement the observational evidence presented in this article.

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Scanning electron microscopy investigation of the interface between disilicate and porcelain, with and without intermediate glaze, it could reveal differences in the morphology of the transition zone and in The presence of interfacial defects. This type of morphological analysis would contribute to understanding. of the mechanisms by which the glaze layer improves adhesion and for the optimization of parameters application and burning.

The training of laboratory professionals and the technical supervision of processes in teaching centers. and reference laboratories are the most direct pathways for incorporating this protocol into Routine practice. The dissemination of knowledge among professionals at different levels of experience, through the publication of scientific articles, participation in courses and congresses and Mentoring in reference laboratories allows protocols validated by practice to achieve a broader base of ceramic technicians. This exchange of experiences, which already occurs in centers International organizations dedicated to dental ceramics contribute to raising the quality standard of... restorations delivered to patients.

8. Final considerations

Delamination of the porcelain veneer over lithium disilicate infrastructures is a defect. A preventable technique. Understanding the adhesion mechanisms at the interface, rigorous control of the Factors that contribute to failure and the adoption of laboratory protocols that strengthen the collaboration between... Layers are the tools available to the prosthetic technician to minimize this occurrence.

The intermediate glaze layer with Glaze Powder or Glaze Paste IPS e.max Ceram, applied before Unlike conventional stratification, it acts on the three adhesion mechanisms: it improves wetting, It fills surface defects and attenuates the CET gradient at the interface. The protocol adds a The burning step is advantageous in laboratory workflow, but the gains in adhesive safety and longevity of the... Restoration justifies the investment.

The distinction between the glaze materials of the IPS e.max system is important technical information. The practice that this article documents is based on the authors' laboratory experience. The use of The product being placed in the correct stage of the protocol is a prerequisite for the benefits of the intermediate layer. Let them speak out. The dissemination of this information through publications, training courses and... Dialogue between laboratory professionals and clinicians is fundamental for the continuous improvement of... Lithium disilicate stratification protocols.

The scientific and laboratory community has the opportunity to formally investigate A technique already adopted in professional practice, with consistent results. Experimental validation. The intermediate glaze layer protocol will strengthen the evidence base on adhesion in

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bilaminate ceramic systems and will contribute to the clinical predictability of aesthetic restorations.
in lithium disilicate.

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Ivan Pereira dos Santos is a Dental Prosthesis Technician, graduated from Escola Butantã, registered under number TPD 11682 with the Regional Council of Dentistry of São Paulo. He has over 27 years of experience in the field of dental prosthetics, specializing in ceramic veneers, dental contact lenses, implant-supported prostheses, and advanced techniques for layering and applying porcelain to multiple structures.

He worked for 20 years at the Júlio Dental Prosthetics Laboratory in São Paulo, where he served as Technical Coordinator and Head of the Ceramics Department, being responsible for the production of ceramic prostheses, as well as the training and supervision of the technical team. During this period, he worked with leading figures in Brazilian dentistry, including Prof. Dr. Dario Adolf and Dr. [Name missing].
Reinaldo Missaka and Dr. Renata Moraes, among others.
Between 2008 and 2015, he worked as Technical and Dental Ceramics Coordinator in specialization courses in Dental Prosthetics at the Centro Universitário do Norte Paulista (UNORP-SP) and the Centro Universitário Hermínio Ometto (FHO-UNIARARAS), participating in teaching and training activities for professionals in several Brazilian states, including São Paulo, Pernambuco, Brasília, Salvador, Aracaju, and Rio de Janeiro.

Since 2016, he has been the General Director of the Excellentia Laboratory in São Paulo, where he works with analog and digital prosthetic systems for all types of prostheses on the market. He has experience in the development and handling of ceramic materials and in CAD/CAM technologies.
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He is co-author of the scientific article "Torque precision and deviation in mechanical TLDs: implications for implant-supported restorations", published in the Journal of Dental Health, Oral Disorders & Therapy in 2026 (DOI: 10.15406/jdhodt.2026.17.00660), and author of the technical book "Lithium Disilicate in Practice: Adhesion and Stratification Protocols with the IPS e.max System".

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