Effect of Crystallization on Translucency of Zirconia Reinforced Lithium Silicate

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Dedication

Words can never express my sincere thanks to ***My Father and My Loving Husband*** *for their generous emotional support and continuous encouragement, which brought the best out of me. I owe them all every achievement throughout my life.*

To ***My Mother, My Son & My Daughters***

بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

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Introduction

An esthetically pleasing restoration should mimic the natural tooth in terms of shade, shape, size, surface texture and translucency. Although porcelain fused to metal restorations have a long history of clinical application and success, the opaque metal substructure cause undesirable light reflection and accordingly esthetically unpleasant restorations. The increased demand of patients for natural looking restorations has resulted in the development of new all-ceramic systems with deeper translucency similar to natural tooth. Besides hue, chrome, and value, translucency of the restorative material is emphasized as one of the primary factors in controlling the esthetic outcome because it give natural "lifelike" appearance and vitality of complete restoration.

Translucency of the material depends on transmission of light but not the scattering, thus if most of the light that passes through the ceramic is intensely scattered, diffused or reflected, the transmission will be low and consequently the materials will have an opaque appearance. On the other hand, if only part of light is scattered and the majority is transmitted the materials appear translucent. High translucency materials can be used to imitate lightly shaded natural teeth and when high level of esthetics is required, while materials with low translucency can be used in order to imitate or mask more darkly shaded teeth.

Translucency of ceramic material is influenced by many factors including the thickness of the material. The Shade of ceramic material is another important factor for translucency and esthetics of restorations.

Technological development in the dental industry particularly in the field of ceramic materials, enabled to production of high strength monolithic (full contour) materials with qualitative improvement provided materials with many advantages over multilayer structure as long terms success with optimal mechanical properties and excellent esthetics.

Recently, new monolithic machinable ceramic based materials for CAD/CAM technique have been introduced as zirconia reinforced lithium silicate. Celtra Duo variation of Zirconia reinforced lithium silicate (ZLS) is a final crystallized (tooth- colored) material that can be processed in two different ways either milled and polished or milled and firing to improves the flexural strength of material. However, the effect of firing on the optical properties of the material is still not clear.

Review of Literature

Recent advances in technologies and materials in terms of high strength monolithic restorations have allowed esthetically successful restorations with optical properties similar to those of natural tooth. Knowledge of the composition, microstructure and properties of a material is critical for selecting the right material for specific applications as manufactures have recently developed ceramic systems with varying transmittance (high and low translucency materials in order to offer a better range of light transmission for different clinical situations[1,2,3].

Ceramics:

The word "ceramics" is derived from the Greek word "keramos" that means "burnt earth". It came from the ancient art of fabricating pottery where mostly clay fired to form a hard, brittle object. Different definitions have been used to define and describe ceramics. The traditional definition refers to the term ceramic as any product made from a nonmetallic inorganic material usually by firing at a high temperature. A more modern definition is a material that contain metallic and nonmetallic elements (usually oxygen) to provide desirable inherent properties they form hard, stiff, and brittle materials due to the nature of their inter-atomic bonding which is ionic and covalent[4,5,6]. In 2013 the version of the ADA code on the Dental procedures and Nomenclature defines the term porcelain- ceramic as pressed, fired, polished, or milled materials containing predominantly inorganic refractory porcelain, glasses ceramics and glass-ceramics.[7]

In the past decades, ceramic material improvement has paced significantly and their usage has been more abundant. It was due to their superior mechanical properties, biocompatibity, translucency, fluorescence and chemical stability. They also have coefficient of thermo-linear expansion close to dental composition, as well as compression and abrasion resistance. These properties lead to increased interest of ceramic material in dentistry and enable it to perfectly mimic the appearance of natural teeth[8,9]. However their brittle nature and high susceptibility to fracture in condition when there are high tensile stress are major disadvantages to their use.[10,11]

Ceramics can be very translucent to very opaque. In general the more glassy the microstructure the more translucent it will appear, and the more crystalline, the more opaque. Many other factors contribute to translucency as particle size, particle density, refractive index, and porosity. The crystalline phase is responsible for the mechanical properties of materials.

Dental ceramic materials can be found in a glass form (amorphous solid) which has no crystalline phase, a glass with varying amounts and types of crystalline phase, a mostly crystalline material with small amounts of glass; all the way to a polycrystalline solid (a glass free material).[4,5]

Different classification systems have been proposed that focus on the microstructure, composition, clinical indications, fabrication methods, firing temperatures, ability to be etched, translucency, fracture resistance, abrasiveness and antagonist wear the microstructures classification of ceramics i.e amount and type of crystalline phase and glassy phase). Also their processing technique classification; powder-liquid, pressed, machined[12,13]

By using computer-aided design/computer aided manufacturing (CAD/CAM) technology production of an all-ceramic restoration with many enhanced physical and mechanical properties over existing all-ceramic systems have been developed[16]. In recent years, CAD/CAM production has clearly expanded the use of materials for dental prostheses by providing access to new ceramic materials with high dependability[17]. Ceramic restorations produced by machining industrially fabricated blocks may optimize structural reliability avoiding laboratorial processing drawbacks as voids, cracks and flaws[18]. Also another advantage of CAD/CAM technology is the more conservative preparations due to developing of ceramic materials with high mechanical properties.[19]

Microstructure classification:

At the level of microstructure, ceramics can be defined according to nature of their composition of glass to crystalline ration. Ceramic can be classified in to four basic composition categories:

- **Composition category 1** – glass-based systems (mainly silica),
- **Composition category 2** – glass-based systems (mainly silica) with fillers, usually crystalline (typically leucite or, more recently, lithium disilicate),

- **Composition category 3** – crystalline- based systems with glass fillers (mainly alumina)
- **Composition category 4** – polycrystalline solids (alumina and zirconia)

Glass – based systems (mainly silica)

Glass-based systems are made from materials that contain mainly silicon dioxide (also known as silica or quartz), which contains various amounts of alumina.

Aluminosilicates found in nature, which contain various amounts of potassium and sodium, are known as feldspars. Feldspars are modified in various ways to create the glass used in dentistry. Synthetic forms of aluminosilicate glasses are also manufactured for dental ceramics.

Glass-based systems with fillers

This category of materials has a very large range of glass–crystalline ratios and crystal types. The glass composition is basically the same as the pure glass category.

The difference is that varying amounts of different types of crystals have either been added or grown in the glassy matrix. The primary crystal types today are leucite, lithium disilicate or fluoroapatite.