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HO CHI MINH CITY UNIVERSITY OF TECHNOLOGY

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THESIS INFORMATION

Title:	**Effects of CeO_2, Nd_2O_3 on the properties of lithium disilicate glass-ceramic for dental restorations**
Major:	Materials Engineering
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Abstract

The glass-ceramics (hereafter referred to as the GCs) are crystalline materials from glasses, produced by controlling the crystallization process through the heat-treatment of glasses with appropriate compositions. The GC with the crystals of lithium disilicate $Li_2O.2SiO_2$ (LS_2) as the main crystal phase is one of the prospective materials in the field of restorative dentistry due to the high bending strength and the ability to apply the hot pressed-ceramic technique. Rare elemental oxides are usually added in small amounts to the material, playing a role as colorants and fluorescent agents. *This thesis studied the various effects of CeO_2 content (0 – 2 wt%), Nd_2O_3 content (0–1 wt%), on crystallization and properties of GC derived from $Li_2O–K_2O–Al_2O_3–SiO_2–P_2O_5$ system.*

By using modern analysis techniques and specialized equipment, the crystallization mechanism, crystallization kinetics, and material structure change were studied. The final GC samples with characteristics: three-point bending strength 197 - 293 MPa> 100 MPa, chemical solubility, heat-shock resistance, radioactivity have suitability as "Monolithic ceramic for single-unit anterior or posterior prostheses adhesively cemented" (type II, class 2a) according to the classification of the standard "ISO 6872-2015 - Dentistry - Ceramic materials". The in-vitro evaluation for apatite-forming ability on the final GC in the simulated body fluid SBF showed the bioactivity of material.

Scientific contributions:

- Based on the analytical and experimental results, the crystallization mechanism and crystallization kinetics of the parent glass 17.04 Li_2O - 3.12 K_2O - 3.41 Al_2O_3 - 74.05 SiO_2 - 2.39 P_2O_5 with the addition of CeO_2, Nd_2O_3 for LS_2 dental glass-ceramic were studied. Thereby, the complex crystallization model of the studied glass system was clarified. The results facilitated the determination of heat-treatment conditions to produce glass-ceramic with desired properties.
- The thesis has contributed data on the use of two rare elemental oxides CeO_2 (0 – 2 wt%), Nd_2O_3 (0 – 1 wt%) with the role of enhancing and adjusting the aesthetic optical properties as well as the influence on crystallization and mechanical, physical, chemical, and thermal properties of lithium disilicate dental glass-ceramic materials. Since being heat-treated at the same conditions, the presence of CeO_2 or Nd_2O_3 tended to reduce the crystallinity and LS_2 crystalline phase forming of the ingots and final GCs. The color of CeO_2-containing samples shifted to yellow, Nd_2O_3 containing samples shifted to blue lilac (blue + red). The color difference and the fluorescence emission of Nd_2O_3 containing samples were higher than these of CeO_2 containing samples. The three-point bending strength and chemical solubility of final GCs adding CeO_2 or Nd_2O_3 were decreased, the Vicker hardness was increased slightly. Nevertheless, The final GC containing 0.75% Nd_2O_3 had high crystallinity, the highest relative amount of LS_2 phase and the highest bending strength, the lowest chemical solubility, relative high Vicker hardness, and the highest fluorescence emission.

Technical contributions:

- The process and fabrication parameters for manufacturing LS_2 dental GC materials with addition CeO_2 or Nd_2O_3 using the hot pressing forming technique have been determined.
- The physicochemical transformation models and material structure were clarified by applying suitable analytical methods (DTA, thermal microscopy, XRD, FTIR, XPS, SEM). Besides, the characteristic properties of the material were quantified by effective evaluation methods (translucency measured by two different methods, fluorescence, volumetric density, etc.) It is thereby possible to shorten the translation from research to application. In particular, the thermal microscopy analysis applying to study the deformation process of glass-ceramic ingots and determine the temperature range of hot pressing to shape the final glass-ceramic product has shown the effectiveness of this method. This has not been found in previous publications.

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