# Author's Accepted Manuscript

Viscoelastic Finite Element Analysis of Residual Stresses in Porcelain-Veneered Zirconia Dental Crowns

Jeongho Kim, Sukirti Dhital, Paul Zhivago, Marina R. Kaizer, Yu Zhang



www.elsevier.com/locate/imbbm

PII: S1751-6161(18)30335-7

DOI: https://doi.org/10.1016/j.jmbbm.2018.03.020

Reference: JMBBM2729

To appear in: Journal of the Mechanical Behavior of Biomedical Materials

Received date: 18 January 2018 Revised date: 12 March 2018 Accepted date: 15 March 2018

Cite this article as: Jeongho Kim, Sukirti Dhital, Paul Zhivago, Marina R. Kaizer and Yu Zhang, Viscoelastic Finite Element Analysis of Residual Stresses in Porcelain-Veneered Zirconia Dental Crowns, Journal of the Mechanical Behavior of Biomedical Materials, https://doi.org/10.1016/j.jmbbm.2018.03.020

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting galley proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

### ACCEPTED MANUSCRIPT

Revised and Re-Submitted to Journal of the Mechanical Behavior of Biomedical Materials

## Viscoelastic Finite Element Analysis of Residual Stresses in Porcelain-Veneered Zirconia Dental Crowns

Jeongho Kim<sup>1</sup>, Sukirti Dhital<sup>1</sup>, Paul Zhivago<sup>2</sup>, Marina R. Kaizer<sup>2</sup>, and Yu Zhang<sup>2</sup>

<sup>1</sup>Department of Civil and Environmental Engineering, University of Connecticut, 261 Glenbrook Rd., U-3037, Storrs, CT 06269

<sup>2</sup>Department of Biomaterials and Biomimetics, New York University College of Dentistry, 433 First Avenue, New York, NY 10010

#### **Abstract**

The main problem of porcelain-veneered zirconia (PVZ) dental restorations is chipping and delamination of veneering porcelain owing to the development of deleterious residual stresses during the cooling phase of veneer firing. The aim of this study is to elucidate the effects of cooling rate, thermal contraction coefficient and elastic modulus on residual stresses developed in PVZ dental crowns using viscoelastic finite element methods (VFEM). A three-dimensional VFEM model has been developed to predict residual stresses in PVZ structures using ABAQUS finite element software and user subroutines. First, the newly established model was validated with experimentally measured residual stress profiles using Vickers indentation on flat PVZ specimens. An excellent agreement between the model prediction and experimental data was found. Then, the model was used to predict residual stresses in more complex anatomicallycorrect crown systems. Two PVZ crown systems with different thermal contraction coefficients and porcelain moduli were studied: VM9/Y-TZP and LAVA/Y-TZP. A sequential dual-step finite element analysis was performed: heat transfer analysis and viscoelastic stress analysis. Controlled and bench convection cooling rates were simulated by applying different convective heat transfer coefficients 1.7E-5 W/mm<sup>2</sup> °C (controlled cooling) and 0.6E-4 W/mm<sup>2</sup> °C (bench cooling) on the crown surfaces exposed to the air. Rigorous viscoelastic finite element analysis revealed that controlled cooling results in lower maximum stresses in both veneer and core layers

#### Download English Version:

# https://daneshyari.com/en/article/7207061

Download Persian Version:

https://daneshyari.com/article/7207061

<u>Daneshyari.com</u>