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ELASTIC AND INELASTIC PROPERTIES OF METAL-PORCELAIN COMPOSITES APPLIED TO FUNCTIONALLY GRADED METAL-CERAMIC DENTAL RESTORATIONS

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ABSTRACT

In this work, the elastic and inelastic properties of metal-porcelain composites used in dental restorations were assessed. The monolithic materials (metal and porcelain) as well as the composites with 20M, 40M, 60M and 80M were studied. The metal-porcelain composites exhibited enhanced mechanical properties for higher metal contents.

Keywords: dental restorations; metal-ceramic composites; Young's modulus; shear strength.

INTRODUCTION

A metal-porcelain dental restoration comprises a metal shell on which is fused a porcelain veneer in a high heat oven - porcelain-fused-to-metal technique (PFM). The metal framework provides compression and tensile strength, and the porcelain provides the crown a white tooth-like appearance. These restorations strongly depend on the success of the bond between porcelain and the metal substrate. Despite the great survival rates of metal-ceramic restorations, the failures of these systems are often related to mechanical failues at the interface between metal and porcelain. The solution to overcome problems related to the bonding of two materials with such different natures (mechanical properties' mismatch) can have an answer in natural teeth. Natural teeth are composed by two distinct materials: enamel and dentin with ~65GPa and ~20 GPa Young's Moduli, respectively. They are bonded by dentin-enamel-junction (DEJ) where the Young's modulus changes linearly from that of enamel to that of dentin, thus reducing dramatically the stress in the enamel (Huang et al. 2007) and acting as a natural functionally graded material (FGM). By definition, a FGM is a heterogeneous composite material containing a number of constituents which exhibit a compositional gradient from one surface of the material to the other subsequently resulting in a material with continuously varying properties (Suresh and Mortensen, 1998).

It was showed elsewhere (Henriques et al., 2011) that the use of a metal-porcelain composite interlayer at the interface between metal and porcelain in dental restorations were regarded for significant improvements in their bond strength. This study is devoted to the mechanical characterization (elastic and inelastic properties) of the composites used as interlayers.

RESULTS AND CONCLUSIONS

The results from the shear tests are shown in Fig. 1. The load-displacement curves for the different composites are plotted in Figure 1 and it shows that shear strength increases with the

increasing content of the metallic phase in the composites. Table 1 shows the results for Young's modulus and shear strength for the composites and monolithic materials.

Table 1 - Mechanical properties of metal-porcelain composites

Composites	E [GPa]	Shear strength Load [N]
0M	52	1020
20M	63	2120
40M	89	2106
60M	145	6111
80M	200	11960
100M	220	12350

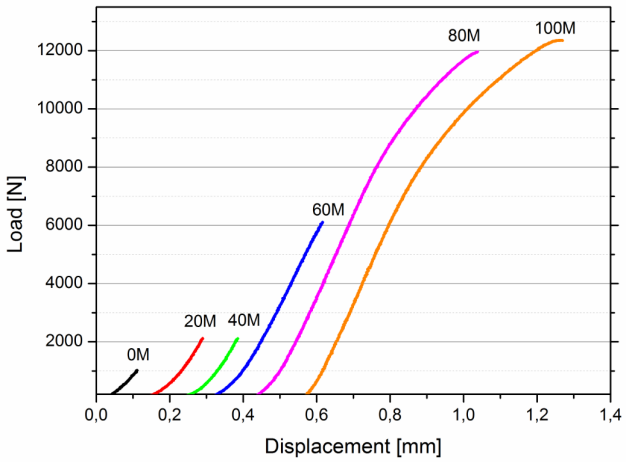

Fig. 1 - Plot of the load-displacement curves obtained in the shear test of metal-ceramic composites and monolithic base materials.

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