Experimental FBG Sensing System and FEA for the Analysis of Dental Macro Implants

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ABSTRACT: In this work Fiber Bragg Grating sensors (FBG) are used to assess the strain profile of macro dental implants under external loads and the results are compared to the corresponding Finite Element Analysis (FEA).

**FBG**

- FBGs are being applied to assess strains in different fields of engineering, e.g. dental implants of orthopedic applications, and the results are compared to Finite Element Analysis (FEA).

**Macro dental implants under study**

- Some research focused on the use of FBG sensors for dental implants, providing a comparison between FBG sensors and traditional strain gauges. FBG sensors are non-invasive, lightweight, and their resolution is compatible with the requirements of the dental field.

**51 FBG**

- In this study, the performance of 51 dental implants composed of different materials was evaluated using FBG sensors. Different materials were studied, and the results were compared to Finite Element Analysis (FEA) results.

**FBG vs. Finite Element Analysis**

- Comparison between numerical and experimental results for a 50N static load:
  - Metal-plastic implant was used.
  - 3 locations of interest were analyzed: 1) at the tip of the implant, 2) 6.5mm lateral to the implant, and 3) near the collar of the implant.

**FBG in horizontal Optical Fibers**

- 40 FBGs were distributed among 8 optic fibers to evaluate the occurrence of transverse strain around the implant.

**FBG in vertical Optical Fibers**

- The load transfer is not homogeneous for the metal implant being much higher below it and not for the plastic and metal-plastic implants exhibiting more homogeneity which favors a good bone remodeling and consequently long implant life.

**CONCLUSIONS**

- For V3m FBG (below the implant) strain increases with depth confirming that load is transmitted downwards by the screw thread and not by the bottom tip.
- For V2m and V4m strain increases with load while keeping the relative distribution confirming that distribution.
- For V5m by the side of the implant strain decreases with depth confirming that the screw thread transmits load efficiently (the collar has to contact with the bone).
- For V12 and V14 (metal) friction replaces compression which may be explained by the finite surrounding media and their proximity to the base of the tube.

As for horizontal FBG, H13 and H23 (near the collar) show high strain as expected but all other FBG (H4 to H8) show very low and random strain making them meaningless.