Dual Dental Matrix Band

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Problem Statement

Surface matrix bands are devices used by dentists to separate adjacent teeth during restorations of interproximal cavities (cavities found in-between two teeth). The matrix band serves to support the restoration material, to provide shape and contour to the tooth being restored, and to protect the adjacent tooth. Ideally, the width of the space between the two adjacent teeth is just large enough to fit one matrix band in order to ensure close proximal contact area, which prevents food impaction and decay. In the case of two cavities on two adjacent teeth, this process is tedious, as the dentist must complete the process from start to finish for each adjacent tooth individually. The goal of this project is to create a dental matrix band that effectively partitions adjacent teeth for more efficient tooth restoration procedures on interproximal cavities by making it possible to complete two adjacent restorations simultaneously.

Figure 1. Current Sectional Matrix [1]

Figure 2. Sectional matrix with tension ring and wedge [2]

Motivation & Background

- Dental caries is a widespread disease characterized by the gradual breakdown of tooth surfaces [3].
- Caused by microbial activity [3].
- Untreated caries are associated with a 26% increased risk of all-cause mortality, and a 48% increased risk of heart disease mortality [4].
- Class II restorations focus on caries in-between two teeth, affecting both adjacent teeth [5].
- Current matrix devices are inefficient and tedious, requiring treatment of one tooth at a time to preserve proximal contact [6].
- Want a device which allows for simultaneous filling of two adjacent interproximal cavities, without compromising proximal contact.

Figure 3. Tooth filling with traditional sectional matrix [7]

Design Criteria

- Function similarly to existing surface matrices
- Dimensions 10-15 mm ht, 12-18 mm wt, <0.05 mm thick
- Maintain tight proximal contact
- Improve filling work flow
- Compatibility with existing process and tooling
- Budget ~$200

Final Design

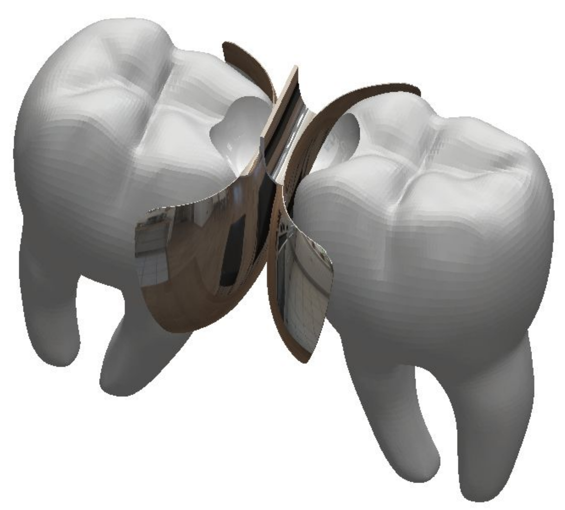

Figure 4. SolidWorks Model of design in teeth

- Two sided design
- Hole allows for single thickness
- Used templates and dremel to cut flats
- Molded flats with 3D printed mold
- Similar shape to traditional sectional matrices
- 304 Full hard SS and 301 Half hard SS heat treats

Figure 5. Final Design in tooth model

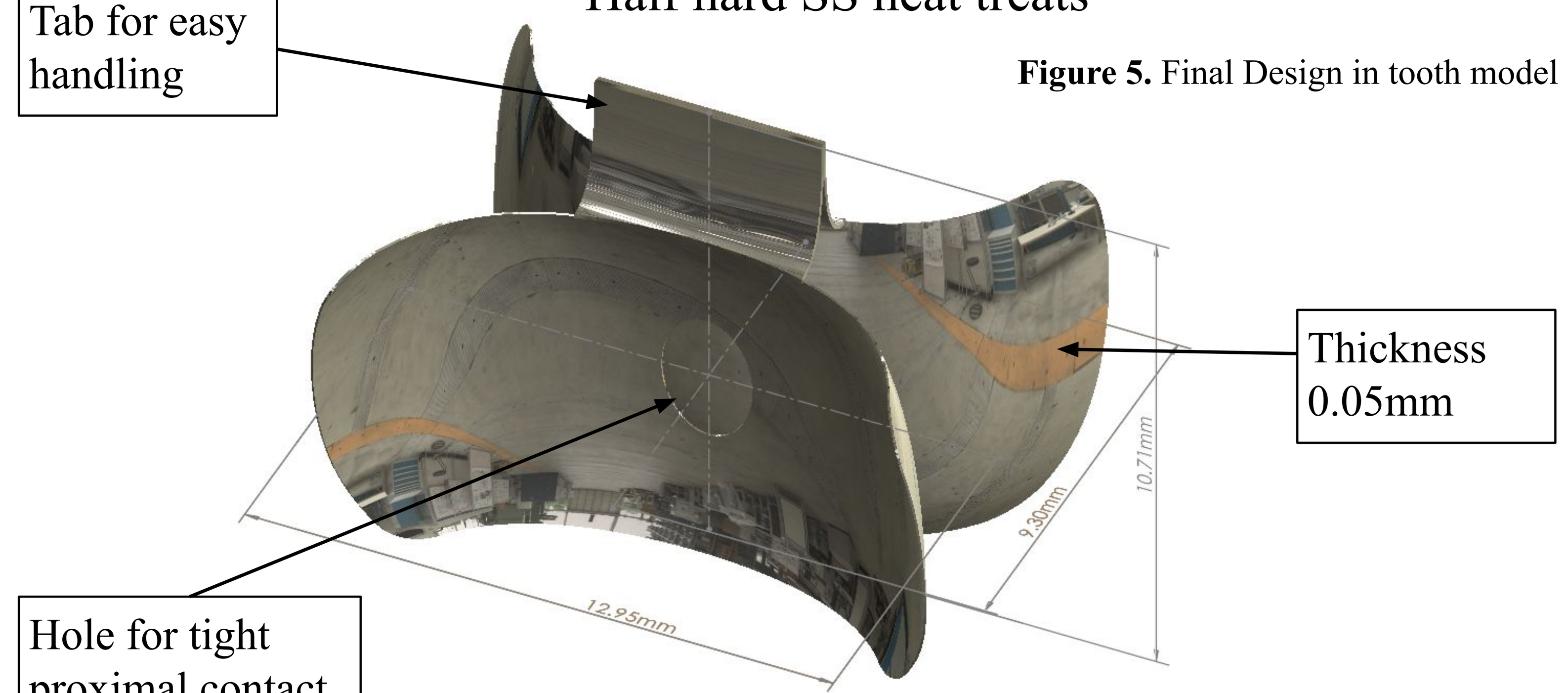

Figure 6. SolidWorks Model of Hole Design

Testing

- A MTS machine was used to test the material properties of the different matrices.
- Tensile testing took place on the following matrices:
  - 3 sample matrices that are currently used in the field
  - 3 304 Full Hard stainless steel test sample fillets
  - 3 301 Half Hard stainless steel steel test fillets
- Stress-strain curves were obtained for each test.
- Compatibility testing of the matrix in a dental model
- A SolidWorks FEA analysis was also performed

Figure 7. MTS material testing.

Results & Discussion

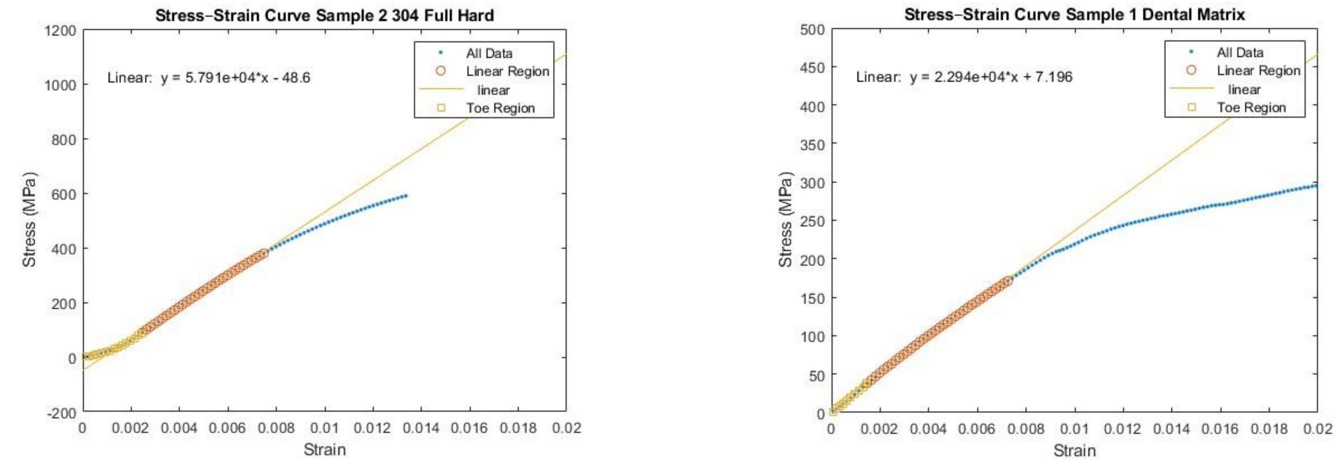

Figure 8. Stress - Strain Curve from one sample of 304 full hard steel and one sample of a currently used dental matrix

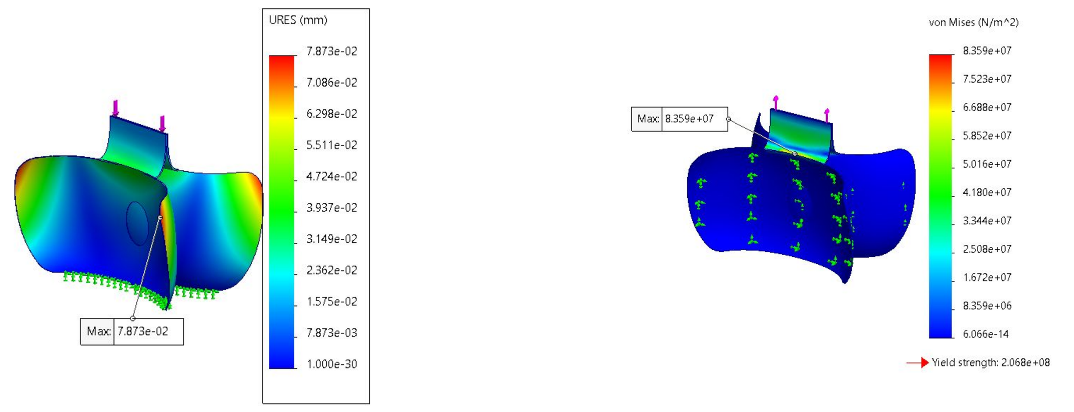

Figure 9. Solidworks FEA analysis of the 304 stainless steel for tensile and compressive forces, with deflection and Von Mises stress outputs.

- Both purchased steels had similar moduli averages of 53.13 GPa and 55.04 GPa for 304 full hard and 301 half hard, respectively.
- These are both stiffer than the sampled dental matrix steel at 14.77 GPa.
- These results show that the team's chosen steel is more stiff than what is used by the market.
- The safety factor of the device when subjected to 4.448 N of tensile force is equal to 6.185; ultimate strength and Von Mises stresses were used.
- This product will not fail due to the application of tensile force during the removal process.

Future Work

During the next semester, we will improve on our fabrication by using a metal laser cutter to improve the dimensional consistency and accuracy of the prototype and send out our design to dentists for review [8]. We will also look into swapping materials if the increased stiffness becomes a problem in further testing. Finally, force gauge testing will be conducted to determine the force necessary to remove and insert a sectional matrix band in comparison to the dual matrix band.

Acknowledgements

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References

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