Bonding PMMA with Titanium for Dental Implants

By Zhong Yuan Luo

Objective

The objective of this project is to prevent the debonding of poly(methyl methacrylate) (PMMA) from Titanium (Ti) metal in dental implants.

Introduction

Dental implants are artificial devices that replace natural teeth for both enhanced utility and esthetics. Figure 1 below shows the differences between a natural tooth and an artificial one. Notice the crown area where debonding is a problem.

Methods and Materials

The PMMA-Ti bond is achieved by introducing a third layer sandwiched in between the two layers and chemically bond them together. That third layer is generated using “self-adhesive” diazonium chemistry which can easily graft to various types of surfaces. Figure 3 below illustrates the general concept.

Advantages of this type of chemistry:

• All reactions take place in an aqueous solution
• The reactions are self driven i.e. no extra setup is required

Issue with aqueous solution, and resolution:

Since the monomer (MMA) is not soluble in water, a surfactant called sodium dodecyl sulfate (SDS) is used to form micelles around MMA molecules and bring them in contact with the diazonium salts dissolved in an acidic solution. The process is shown in Figure 6.

Results

XPS (X-ray photoelectron spectroscopy)

Various samples are produced with either only the PAP or PMMA + PAP layer. The XPS spectroscopy is used to analyze the different elements that are present on the surface.

Results (continued)

As shown in Figures 9a-c, the surface treatment causes a drastic change in color. Therefore, visual inspection of samples upon termination of the reaction is a very fast way to determine if the reactions were efficient.

Conclusion

• Diazonium chemistry provides a very fast and effective route to the modification of the surface and the addition of PMMA layer
• XPS characterization shows stable bonding of PAP layer onto titanium substrate
• Further mechanical tests will be performed to determine the change in interfacial strength

Project made possible and special thanks to:
• NSERC-USRA fund
• Xuan Tuan Le
• Gul Zeb

References

GiulZeb
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The project is an investigation of debonding between heat-cured PMMA and titanium alloy (Ti-6Al-4V).

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