University of Mississippi Medical Center
School of Dentistry
Research Day 2019
February 19, 2019

David A. Felton, DDS, MS
Dean

Jason A. Griggs, PhD, FADM
Associate Dean for Research

School of Dentistry | Office of Research
University of Mississippi Medical Center
2500 North State Street, Room D528-6A
Jackson, MS 39216-4505
Dear Colleagues,

It is indeed a pleasure to welcome you to the 2018 UMMC School of Dentistry Research Day, an annual tradition at the School since 1994! Today our faculty, students, and postgraduate students come together to present their research findings to the members of the School of Dentistry and our Medical Center colleagues. Consider the advances that we’ve seen in dentistry over the past few decades—new dental materials, dental implant therapies, the development of systematic reviews, digital and CAD/CAM dentistry, advances in adhesive dentistry, advances in pulpal and periodontal research, dental caries assessment and management, and the movement toward minimally invasive dentistry—the list is impressive! Few, if any, of these advances would have occurred without dental research efforts. Research is critical to advancing dentistry and the dental specialties.

Having our students participate in research is an excellent way to advance the science of dentistry beyond the classroom and clinical environment. In addition, according to the Commission on Dental Accreditation (CODA, Standard 6-3), “Dental education programs must provide opportunities, encourage, and support student participation in research and other scholarly activities mentored by faculty.” Our faculty, and others within the UMMC system, continue to serve as excellent mentors and role models for our students in the research arena. As you will witness, the quality of the research presented today strongly supports our goal to not only achieve the CODA accreditation standard, but to surpass it.

I am confident that you will enjoy these outstanding research presentations, and that you will witness, first hand, as our students, residents, and faculty demonstrate excellence in their research efforts. I extend my heartiest welcome to our Dental Research Day, and encourage you to enjoy the presentations, and celebrate our student’s accomplishments with us!

David A. Felton, DDS, MS, Dean
Dean, School of Dentistry
Professor, Department of Care Planning and Restorative Sciences

This has been an exciting year for research in the School of Dentistry. We had 17 peer-reviewed publications and brought in over $1.5M in extramural funding. We also submitted 20 student abstracts to national and international conferences, which is the largest number of submissions that I can remember our school contributing in a single year.

It is a pleasure to have Dr. Jack Ferracane with us as our keynote speaker this year. He is a distinguished investigator in the area of dental composites, and his scientific expertise is matched by his dedicated service to the profession. Dr. Ferracane has served as an inspiration and good example for me throughout my career.

As usual, the abstracts that we received this year are excellent, and I look forward to hearing our students and faculty present their results and discuss the scientific impact with all of you. Thank you for joining us.

Jason A. Griggs, PhD, FADM
Associate Dean for Research, School of Dentistry
Professor and Chair, Department of Biomedical Materials Science
Program

Lower Amphitheater R153

8:00 – 9:00 am  Keynote Lecture: Dr. Jack L. Ferracane, PhD
“Is the Polymerization Stress Produced During the Curing of Dental Composite Restorations Clinically Meaningful?”

Nelson Student Union Conference Rooms A and B

9:00 – 9:30 am  Break / Breakfast food served
Poster preparations

9:30 – 11:30 am  Poster presentations
Judging of student posters

Nelson Student Union Conference Rooms C and D

11:30 am  Lunch will be served

12:15 pm  Awards presentation

12:45 pm  Poster removal

Acknowledgements

Faculty Research Mentors
Ahmad Abdelkarim, DMD, MS, PhD, EdD
Associate Professor & Chair, Orthodontics
Jennifer Bain, DMD, MSPH, PhD
Associate Professor & Chair, Periodontics and Preventive Sciences
Elizabeth Carr, DHA, RDH, MAADH
Associate Professor & Chair, Dental Hygiene
Ravi Chandran, DMD, PhD
Associate Professor & Chair, Oral Maxillofacial Surgery & Pathology
Teresa Duncan, MDH, BS, RDH
Assistant Professor, Dental Hygiene
Yuanyuan Duan, BDS, MS, PhD
Assistant Professor, Biomedical Materials Science
David Felton, DDS, MS
Professor, Care Planning & Restorative Sciences
Dean, School of Dentistry
Jason A. Griggs, PhD, FADM
Professor & Chair, Biomedical Materials Science
Associate Dean for Research
Christopher V. Hughes, DMD, PhD
Chair & Program Director, Pediatric Dentistry & Community Oral Health

Charles Ramsey, DMD
Assistant Professor, Care Planning & Restorative Sciences
Michael Roach, PhD
Associate Professor, Biomedical Materials Science
Susana Salazar Marocho, BDS, MS, PhD
Assistant Professor, Biomedical Materials Science
Niping Wang, DDS, PhD
Assistant Professor, Periodontics and Preventive Sciences
Scott Williamson, PhD
Assistant Professor, Biomedical Materials Science
Director, Shared Equipment Facility

Poster Judges
Christopher V. Hughes, DMD, PhD
Chair & Program Director, Pediatric Dentistry & Community Oral Health

Tamara Nelson, MLIS, EdS
Assistant Professor, Academic Information Services
Kenneth St. John, PhD
Professor Emeritus, Biomedical Materials Science

School of Dentistry Administration
Dr. David A. Felton, Dean
Dr. Scott Phillips, Assistant Dean for Clinical Affairs
Dr. R. Scott Gatewood, Associate Dean for Academic Affairs
Dr. Jason A. Griggs, Associate Dean for Research
Dr. John B. Smith, Jr., Assistant Dean for Admissions & Interim Assistant Dean for Student Affairs

Research Advisory Committee
Dr. Jason A. Griggs, Chair  Dr. Pier Paolo Claudio
Dr. Ahmad Abdelkarim  Dr. Amol Janorkar
Dr. Jennifer Bain
Keynote Lecture

“Is the Polymerization Stress Produced During the Curing of Dental Composite Restorations Clinically Meaningful?”

Jack L. Ferracane, PhD
Professor & Chair
Department of Restorative Dentistry
Oregon Health & Science University

Dr. Jack Ferracane is the Professor and Chair of Restorative Dentistry, and Division Director of Biomaterials and Biomechanics at Oregon Health & Science University, Portland, Oregon. Dr. Ferracane received a B.S. in Biology from the University of Illinois, and an M.S. and Ph.D. in Biological Materials from Northwestern University. He is a founding fellow and past-President of the Academy of Dental Materials. He is a past-President of the Dental Materials Group of the International Association for Dental Research. He is a past-President of the American Association of Dental Research. He is a past-President of the Dental Materials Group of the IADR, the Founders Award from the Academy of Dental Materials, and the Hollenback Award from the Academy of Operative Dentistry. He is an honorary member of the American College of Dentists and the Oregon Dental Association. He has recently been inducted as a fellow of the American Institute of Medical and Biological Engineering. He serves on the editorial board of ten journals, and is Associate Editor of the Journal of Dental Research and Odontology. He serves as a regular member of the Oral, Dental and Craniofacial Sciences Study Section [ODCS] of the NIH/NIDCR. He has authored a textbook entitled “Materials in Dentistry. Principles and Applications.” He is a co-editor of a textbook entitled “Summitt’s Fundamentals of Operative Dentistry. A Contemporary Approach,” now in its fourth edition. He has published and lectured extensively on dental materials, including dental composites, adhesives, amalgam, and practice-based dental research. He has provided continuing education at annual meetings of the ADA, British Dental Association, California Dental Association, Chicago Midwinter, Midwest Dental Conference, Oregon Dental Conference, Pacific NW Dental Conference, Southwest Dental Conference, Yankee Dental Congress, and to other professional dental organizations. His current research interests are in developing new monomers for enhanced dental composites, studying the factors that affect biofilm formation around dental composite restorations leading to the recurrence of caries lesions, and the use of bioactive glasses as potential antimicrobial and remineralizing agents in resin-based dental materials. His research is funded by the NIH/NIDCR as well as private industry. He also is actively involved in the establishment and operation of networks designed to conduct dental clinical research in the private practice setting, and is currently involved in a large scale clinical study in the NIH-funded National Dental Practice-based Research Network (NDPBRN) investigating the characteristics and progression of cracked teeth.
**Grinding Damage Assessment of YSZ Based Ceramic Frameworks**

*J Akers¹, B Shiyou¹, J Griggs², P Kirk², S Salazar Marocho¹*

¹Department of Biomedical Materials Science, University of Mississippi Medical Center; ²Department of Care Planning and Restorative Sciences, University of Mississippi Medical Center

**Objectives:** Ceramic restorations which are designed and milled using the CAD/CAM system are being increasingly utilized in dental practice. Yttria-stabilized zirconia (YSZ) ceramic restorations are milled in their partially sintered state which makes them vulnerable to damage from the abrasive diamond burs used in the milling process that could lead to early clinical failure. This study aimed to assess the potential surface damage induced by the milling process of YSZ structures.

**Methods:** Fifteen YSZ frameworks were produced using the MXCL milling unit with diamond burs of 64 μm grit (a step and a cylinder pointed bur 20) operating at 42,000 rpm on the partially sintered YSZ ceramic blocks. Epoxy replicas of the samples were created using a two-step impression technique. The first impression was taken using a high viscosity (heavy body) polyvinyl siloxane material (Extrude), then when the material set, the second step was to add a low viscosity (light body) polyvinyl siloxane material (Extrude) over the first impression. EpoxySet resin and hardener (Allied HighTech Products Inc.) was mixed with the weight ratio of 100:12 (Resin:Hardener). The epoxy was poured into the impressions using a small instrument drop by drop to minimize the amount of bubbles. Buccal, Mesial, Distal, and Lingual were all identified on the samples. The samples were then observed first under the optical microscope (Keyence) for any damage. Samples were then affixed to mounting plates with carbon tape and received a gold coating of 4 nm thickness. The scanning electron microscope (Zeiss) with an EHT of 10.00 kV was used to quantify the damage observed from the optical microscope, as well as quantify damage that was not visible on observation with the optical microscope. Findings were recorded and measured when possible.

**Results:** Chippings and bur markings were observed near or at the margins of the YSZ structures. The average depth and width of the chips are provided in the table below. From sample 1 to 15, the mean size of the chips tended to be larger with longer bur use.

<table>
<thead>
<tr>
<th>Chipping</th>
<th>Quantity</th>
<th>Mean Depth in µm</th>
<th>Mean Width in µm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>140</td>
<td>42.18 (11.79)</td>
<td>262.55 (39.19)</td>
</tr>
</tbody>
</table>

**Bur Markings**

<table>
<thead>
<tr>
<th>Type</th>
<th>Mean Depth in µm</th>
<th>Mean Width in µm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uneven grinding marks</td>
<td>99.79</td>
<td>623.40</td>
</tr>
<tr>
<td>Long crack perpendicular to bur markings on buccal</td>
<td>1254.74</td>
<td></td>
</tr>
</tbody>
</table>

**Conclusions:** Predominantly, chipping was the damage encountered after the milling process of YSZ blocks before final sintering. The damage encountered may cause the YSZ structure to be prone to fracture depending on several factors such as: residual stress field around the chips, and tensile stresses.

**Acknowledgements:** Research reported in this publication was supported by the NIDCR of the National Institutes of Health under award number R01DE024333. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

**Periodontal Referral Patterns of General Dentists with Varying Undergraduate Exposures**

*K. Allen¹, K. Roach¹, J. Bain¹*

¹Department of Periodontics and Preventive Sciences, University of Mississippi Medical Center

**Objectives:** It is currently thought that referral of patients to a periodontist for treatment is in decline. There are different opinions as to why this may be occurring. Therefore, this study aims to determine if different exposures to periodontal procedures in dental school could be playing a role. Furthermore, this study aims to define the relationship between levels of dental education and periodontal referral patterns.

**Methods:** This pilot survey study inquired about the periodontal referral patterns of general dentists and the reasons they refer or choose not to refer certain patients to a periodontist for care. Qualtrics Survey Software was utilized to create the survey and distribute it to general dentists in Mississippi and Alabama. The goal was to have at least 200 dentists participate in the closed ended question survey. Data were analyzed using a stepwise regression analysis to determine significant factors affecting the clinicians’ decision to refer.
**Poster Abstracts**

**Comparison of Anodized Coatings on Wrought and Additively-Manufactured Ti-6Al-4V**

*H Coffey¹, H Johnson¹, A Janorkar¹, R Williamson¹, M Roach²*

¹Department of Biomedical Materials Science, University of Mississippi Medical Center

**Objectives:** Titanium alloys are a common choice for implants due to their biocompatibility, corrosion resistance, and mechanical properties. Thin, amorphous oxide layers spontaneously form on titanium surfaces in contact with oxygen. To enhance bioactivity and osteoblast mineralization, amorphous layers may be anodized to form anatase and rutile oxides. Currently, implants are manufactured from wrought materials through reductive milling processes involving large machinery which produce considerable scrap material. Additive manufacturing (AM) enables the possibility of onsite manufacturing, less scrap production, and rapid prototyping for emergency situations. The objective of this study was to compare and contrast anodized layer structure differences on wrought and AM Ti-6Al-4V (TAV).

**Methods:** 12.7 mm diameter wrought TAV bar stock (Fort Wayne Metals, Fort Wayne, IN) was sliced in 2-3 mm thick samples for the control sample group. AM 12.7 mm diameter by 3 mm thick TAV samples (Cavius, Mississippi State University, Starkville, MS) were manufactured horizontally using laser powder bed fusion (LBF). The as-built AM samples exhibited a “rough” top surface and a “smooth” bottom surface due to the LBF build parameters. Additionally, some AM samples were polished to a 0.05 μm surface finish. Therefore, three AM sample types including AM rough, AM smooth, and AM polished were used in the study. Using a DC rectifier, samples were anodized in 12 V, 10 s steps to a forming voltage of 144 V in a 3.5 M sulfuric acid, 0.19 M phosphoric acid, 0.25 M oxalic acid and 0.75 M hydrogen peroxide solution. All samples were then analyzed by thin-film X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy dispersive spectroscopy (EDS) to characterize the surfaces.

**Results:** XRD revealed that anatase phase oxides were present on all samples, but AM rough surfaces showed a significantly smaller anatase peak. A surface porosity analysis with SEM showed the wrought TAV, AM smooth, and AM polished sample types to exhibit a uniform pore distribution. Wrought TAV and AM polished samples also showed similar oxide thicknesses, while as-built AM smooth surfaces showed a thicker oxide layer. AM rough samples showed an inconsistent oxide layer thickness ranging from 1 - 60 μm. EDS results showed similar phosphorus levels were incorporated into the AM smooth, AM polished, and wrought TAV oxide layers, but AM rough samples incorporated much higher amounts.

**Conclusions:** As-built AM surfaces showed thicker and inconsistent oxide layers compared to the wrought TAV control samples. However, polished AM samples were shown to produce a very similar oxide layer to the wrought TAV counterparts. Therefore, the study suggested AM samples may need post-processing such as milling or polishing prior to anodization to obtain a similar oxide layer to wrought TAV. Future studies will compare the metal/oxide layer interface structures, anodized layer shear strengths, and osteoblast responses to the AM and wrought TAV samples.

**A Comparison of Phosphorus Enhanced Anodization on Titanium Implant Alloys**

*C Hardman¹, M Doukas¹, H Johnson¹, A Janorkar¹, R Williamson¹, M Roach²*

¹Department of Biomedical Materials Science, University of Mississippi Medical Center

**Objectives:** Alpha or beta phase titanium alloys are implanted for applications needing high ductility, while duplex alpha and beta alloys are used for higher load bearing applications. Titanium spontaneously forms an amorphous oxide in aerated environments, but anodization may crystallize the oxide into anatase or rutile. Anodization of commercially pure titanium (CPTi) in H₃PO₄ containing electrolytes was shown to incorporate phosphorus into an anatase oxide that significantly enhanced osteoblast differentiation and mineralization. The objective of this study was to apply the anodization technique to four titanium alloys and compare the resulting oxide layers.
Methods: 12.7 mm diameter bars of CPTi and three duplex alloys including Ti-6Al-4V ELI (TAV), Ti-6Al-7Nb (TAN), and Ti-15Mo (TiMo) were cut into 2 mm thick samples. Samples were anodized in a 3.5 M H₂SO₄, 0.19 M H₃PO₄, 0.25 M C₂H₅O₂, and 0.75 M H₂O₂ electrolyte using a DC rectifier in 12 V, 10 s steps to 144 V. EDS and thin-film XRD were used to compare oxide surface chemistry and crystallinity. AFM and SEM were utilized to compare surface roughness, surface morphology, and oxide thickness. Oxide wettability with distilled water was assessed using the sessile drop technique. Alloy results were compared using one-way ANOVA (α = 0.05) analyses.

Results: All alloys exhibited an anatase oxide containing phosphorus. The remaining surface results are compiled in Table I. CPTi, TAV, and TAN showed similar surface porosity, despite TAN showing a very different pore distribution. TiMo showed the highest surface porosity. TAN and TiMo revealed the thickest oxide layers, followed by CPTi, and TAV. Despite differences in thickness and porosity, all alloys showed similar surface roughness and hydrophilicity.

Conclusions: A hydrophilic, anatase oxide with phosphorus incorporated was anodized onto each alloy. However, differences were shown in surface porosity nanoscale features on the alloy surfaces. Future studies will compare osteoblast response to each anodized alloy.

Table I - Titanium Alloy Anodization Comparison

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Percent Porosity* (%)</th>
<th>Oxide Thickness** (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPTi</td>
<td>12.7 ± 0.3b</td>
<td>3.85 ± 0.67b</td>
</tr>
<tr>
<td>TAN</td>
<td>14.3 ± 1.1b</td>
<td>5.07 ± 1.39b</td>
</tr>
<tr>
<td>TAV</td>
<td>12.1 ± 0.3b</td>
<td>3.24 ± 0.53c</td>
</tr>
<tr>
<td>TiMo</td>
<td>20.35 ± 1.41A</td>
<td>4.86 ± 0.87A</td>
</tr>
</tbody>
</table>

Objectives: To determine the relationship between fracture toughness (Kᵣ) and the fractal dimensional increment (D*) of the fracture surface calculated using a new and unbiased technique on ceramic benchmark materials (Si₃N₄ and silica glass).

Methods: The Kᵣ of rectangular beams of NIST standardized Si₃N₄ (SRM2100, n = 10) and silica glass (Viosil SX, n = 6) was evaluated by the SCF method according to the ASTM C1421 with a Knoop indentation followed by four-point flexure in deionized water. Fracture surfaces were analyzed using fractography and fractal analysis. The critical flaw sizes were measured using a scanning electron microscope. Epoxy replicas of the mirror region of the fracture surfaces were prepared. The Si₃N₄ replicas were scanned using atomic force microscopy as follows: 5 µm x 5 µm scanning area with 512 lines at a rate of 0.592 Hz. The surface height data was imported into a custom MathCAD script, and FRACTALS software was used to determine D* by the Minkowski cover technique. The silica glass replicas were analyzed using the traditional Slit-Island Richardson technique to calculate D*.

Results: The mean ± standard deviation Kᵣ and D* for Si₃N₄ were calculated as 4.62 ± 0.14 MPa•m¹/₂ and 0.13 ± 0.01, respectively. The values for silica glass were 0.93 ± 0.20 MPa•m¹/₂ and 0.10 ± 0.04, respectively.

Conclusions: The calculated Kᵣ values for Si₃N₄ and silica glass agree closely with previously reported values for those materials (NIST). Linear models relating Kᵣ and the square-root of D* for previously investigated materials fit well to the data for Si₃N₄ (R² = 0.99) and silica glass (R² = 0.96). This validated method may now be used to estimate the fracture toughness of dental FDP and implant specimens that have failed clinically.

Acknowledgments: Research reported in this publication was supported by the NIDCR of the National Institutes of Health under award number R01DE024333. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.
Poster Abstracts

Pulse Repetitions Effect on Temperature Through a Y-TZP Ceramic

L Stringer1, S Malley2, D Hutto3, J Griggs2, S Salazar Marocho2

1Department of Psychology and Neuroscience, Millsaps College; 2Department of Biomedical Materials Science, University of Mississippi Medical Center; 3Department of Care Planning and Restorative Sciences, University of Mississippi Medical Center

Objectives: Removing yttrium-stabilized tetragonal zirconia polycrystalline (Y-TZP) ceramic restorations with diamond burs is time-consuming and destructive. Using an erbium, chromium: yttrium-scandium-gallium-garnet (Er,Cr:YSGG) laser could be a fast and non-destructive alternative method. Previous research shows that a lower power setting of 2.5 W does not produce temperatures (>42 °C) that could damage the tooth pulp [1, 2]. Those settings are in the range of the ones used for soft tissue cutting and bone crown lengthening. However, they can harm the soft and hard tissue when the intended additional use of the laser is to de-bond the Y-TZP restoration. Thus, the main objective of this study was to measure the energy that is transferred through a Y-TZP structure using a lower power of 1.0 W at different pulse per seconds.

Methods: Y-TZP slices of 1.01 ± 0.05 mm thickness were produced and sintered. A mounting system was created to hold the laser in place to improve accuracy and consistency. Y-TZP slices were fixed to a hollowed base using a polymeric clay. The Y-TZP slices were placed underneath the center of each sample to record the maximum temperatures (°C) transferred from the Er,Cr:YSGG laser (Biolase Waterlase MD). Three experimental groups (n = 10) were tested at 1.0 W with three different pulses per second (PPS) as follows: 20, 30 and 45. The samples were irradiated for either 30 and 60 seconds with a constant air and water combination of 1%.

Results: Two-way ANOVA was performed since data for changes in temperature passed the normality test. Results showed that time was not significant (p = 0.866) but that frequency was highly significant (p < 0.001). The data for maximum temperatures were not normally distributed, so the Kruskal-Wallis one-way ANOVA was used for ranking. The test showed that the maximum temperature at 20 PPS for 30 seconds (27.61 ± 4.78 °C) was significantly higher than that at 45 PPS for both 30 and 60 seconds (22.41 ± 4.86 °C and 21.02 ± 7.5 °C, respectively). Tukey’s HSD test showed that 20 PPS was significantly different and higher than both 30 and 45 PPS, while 30 and 45 PPS were statically equal. Representative samples from each group were examined under the SEM and AFM which showed that the laser settings used did not change the topography of the surface.

Conclusions: The low power setting of 1.0 W with both low and high frequencies could be a potential method for debonding Y-TZP restorations with an Er,Cr:YSGG laser. Although no temperatures exceeded 42 °C, the highest frequency of 45 PPS displayed the lowest temperatures, making this the most suitable parameter.

Acknowledgements: Supported by the School of Dentistry Intramural Research Support Program (award #18-03), Biomedical Materials Science Share Equipment Facility School of Dentistry, UPSTART and SURE Programs and Mark A. Langston (UMMC Laser Safety Officer).


Bonded and Irradiated Y-TZP Surfaces after Laser Application

D Remley1, L Stringer2, D Hutto3, J Griggs1, M Roach1, S Salazar Marocho2

1Department of Biomedical Materials Science, University of Mississippi Medical Center; 2Department of Psychology and Neuroscience, Millsaps College; 3Department of Care Planning & Restorative Sciences, University of Mississippi Medical Center

Objectives: To characterize the bonded and irradiated surfaces of a Y-TZP ceramic after Er, Cr:YSGG laser application for debonding purposes.

Methods: In previous research [1], slices (1 mm thick) of Y-TZP ceramic (IPS e.max ZirCAD, Ivoclar) were submitted to laser irradiation by the Er,Cr:YSGG laser to debond the ceramic from a dual-cured resin cement (Variolink, Ivoclar). The slices were divided into three groups according to the power setting of the laser, as shown in the table. Following irradiation, a shear bond strength test (SBS) was performed using a wire loop at a loading rate of 1 mm/ min until failure. In this study, the irradiated surface was characterized using the atomic force microscope (AFM) and the scanning electron microscope (SEM). The failure type was analyzed using the optical microscope and the SEM.

Results: Data is shown in Tables 1 and 2:

* signifies presenter if not first author

Bold print signifies student researcher
Table 1. Topography and surface roughness of the irradiated surface of each group.

<table>
<thead>
<tr>
<th>Group</th>
<th>Topography</th>
<th>Surface Roughness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Smooth, no microcracks; no difference between irradiated and non-irradiated surfaces</td>
<td>Ra =198.4 nm</td>
</tr>
<tr>
<td>2.5 W</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 4.5 W  | Localized intergranular microcracks with branches | Between the crack branches: Ra = 61.29 nm  
                                                                 Adjacent to the microcrack: Ra = 30.27 nm |

Table 2. Failure classification after debonding test.

<table>
<thead>
<tr>
<th>Group</th>
<th>Adhesive of the Y-TZP/resin cement interface</th>
<th>Adhesive of the resin cement/resin composite surface</th>
<th>Cohesive of the resin cement</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>2.5 W</td>
<td>22.2%</td>
<td>0%</td>
<td>0%</td>
<td>77.8%</td>
</tr>
<tr>
<td>4.5 W</td>
<td>12.5%</td>
<td>25%</td>
<td>0%</td>
<td>62.5%</td>
</tr>
</tbody>
</table>

Upon SEM examination of the irradiated Y-TZP surface, localized intergranular microcracks with branching were noted on three out of the eight samples from the 4.5 W group. Under the AFM, the surface roughness adjacent to the microcrack was much smoother as compared to between the branches of the microcrack. These observations contrasted with the irradiated Y-TZP surface of the samples in the control group and the 2.5 W groups. In these groups, no microcracks were found as well as no change in the surface roughness. The failure type was predominantly mixed regardless the power setting used.

Conclusions: The laser power settings promoted different topography and surface roughness on the irradiated surface and a similar failure type on the bonded surface. The high power laser setting (4.5 W) and the combination of air and water ablation led to intergranular microcracks on the YSZ surface.

Conclusions: Through our results, we found there is direct correlation with protected, healthier enamel surfaces to have more bound water than the cavitated, hypomineralized enamel surfaces. Our findings of bound water in enamel using the customized Raman spectroscopy are the first to do so and could play a major role for future clinically related research.


**Attitudes of Mississippi Licensed Dentists Toward Dental Therapy Model**

*E Turbeville*, *A Abdelkarim*, *D Felton*, *E Carr*

1Department of Orthodontics, University of Mississippi Medical Center; 2Department of Care Planning and Restorative Sciences, University of Mississippi Medical Center; 3Department of Dental Hygiene, University of Mississippi Medical Center

Objectives: Incorporation of a mid-level dental provider into the oral health care system provides an opportunity for increased access to care for patients in rural or underserved areas, especially in the state of Mississippi in which there is a lack of adequate number of dentists in rural areas. The purpose of this study was to assess the attitudes of dentists in the state of Mississippi towards dental therapy model.

Methods: A survey instrument was designed with four demographic questions (age, gender, faculty status, private practice status), ten statements rated on a Likert scale assessing general acceptance of dental therapy model, and three open-ended questions assessing advantages, disadvantages and perspectives of respondents about dental therapy. After IRB approval, the survey was delivered to 567 licensed dentists in Mississippi, of which 109 dentists completed the survey (response rate of 19%). Mann-Whitney *U* test was used to test the null hypotheses regarding response equality between different groups (age, gender, faculty status, private practice status), with a statistical significance set at 0.05.
Results: In this study, most responses of different groups had no statistical differences (p > 0.05). Overall, the attitudes of licensed Mississippi dentists about dental therapy were remarkably negative. Qualitative data shows that some Mississippi dentists perceive that the model could increase access to care and the number of dental workers. On the other hand, most qualitative data reveal major concerns about insufficient education of dental therapists, reductio of quality of care, creation of two-tier system, endangering the public, inability of dental therapists to manage clinical complications, and several others.

Conclusions: Despite that the dental therapy model was created to address access to care in rural and underserved areas, several of which are located in Mississippi, this model is negatively perceived by licensed dentists and few had positive perspectives about it.

Observation of the Interactions Present between an Elastin-Like Polypeptide and Silica Using Scanning Electron Microscopy and FT-IR Spectroscopy

J Cobb1, V Zai-Rose2, J Correia2, A Janorkar2

1Department of Biomedical Materials Science, University of Mississippi Medical Center; 2Department of Cell and Molecular Biology, University of Mississippi Medical Center

Objectives: Elastin-like polypeptide (ELP) belongs to a class of recombinant proteins that exhibit a reversible phase transition where below its transition temperature (T) the ELP remains soluble in the continuous phase, and above T, the ELP phase separates and stabilizes into coalesced particles. Understanding this behavior is important for ELPs use in applications including drug delivery, gene transfection, and as biologically active coatings. While the solution behavior of ELP has been extensively studied, the interaction between the ELP and a surface has not.

Methods: The SynB1-ELP was prepared at three concentrations 0.8, 1.5, and 3 mg/mL in 1X PBS. A Dynapro Nanostar DLS instrument (Wyatt Tech) was used to show aggregation behavior of SynB1 ELP in solution over a temperature range of 20–50 °C. 10 µL ELP solution was placed onto a silica disk as a droplet, which was kept in a 65 mm culture dish, and aged at 50 °C. Samples were analyzed using a Zeiss Supra 40 SEM with an accelerating voltage of 3 keV. A Perkins-Elmer Spectrum 100 FT-IR equipped with an attenuated total reflectance (ATR) attachment was used to characterize the water content of the samples. A Perkins-Elmer Spectrum 100 FT-IR equipped with an attenuated total reflectance (ATR) attachment was used to characterize the change in secondary structures of the samples.

Results: From 0.5 to 2.5 hours, the ELP stabilizes into particles onto the surface of the silica, which increases in average diameter from 2,558 nm ± 130 nm at 0.5 hours to approximately 4,678 nm ± 230 nm at 2.5 hours. At 3.5 hours, a substantial increase in particle diameter to a final average size of 15,365 nm ± 4,300 nm can be seen. Beyond 5 hours, the larger structures begin to destabilize into smaller particles from a diameter of 8,291 nm ± 1,009 nm at 6 hours to 1,221 nm ± 153 nm at 9 hours. Multiple instrumentation techniques have previously been used to analyze the alteration of secondary structure, but limitations have only provided partial evidence about the correct behavior of ELP during its transition. For FT-IR secondary structure analysis the amide I peak was isolated and deconvoluted using the second derivative method. After peak deconvolution, linear correlations were used to establish positive relationships between secondary structures. An increase in coalesced particle size was determined to be from an increase in beta-helix structures, while a decrease came from the formation of extended chains.

Conclusions: This research demonstrates the complex behavior ELP has when in contact with a surface and can be used to create precisely defined particle sizes and thermo-responsive surfaces.

Acknowledgements: Research reported in this publication was supported by the NIBIB of the National Institutes of Health under award number R01EB020006. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Surface Gas-phase Fluorination for Bonding Monolithic Zirconia Restorations

L Contreras1,3, J Piascik2, J Grigg3, S Salazar Marocho3

1Department of Dental Materials and Prosthodontics, Institute of Science and Technology, São Paulo State University; 2Department of Operative Dentistry, University of North Carolina; 3Department of Biomedical Materials Science, University of Mississippi Medical Center

Objectives: The bonding prognosis of monolithic yttria-stabilized zirconia fixed dental prostheses is not ideal when either of the following conditions exist: lack of mechanical retention in the remaining tooth structure (short clinical crowns, dental erosion, etc.) or lack of chemical bonding of the substrate. Thus, our aims are 1) To optimize the SixOy seed layer of the plasma fluorination treatment on the yttria stabilized zirconia (YSZ) surface to achieve the strongest possible bonding between YSZ and resin-based cements, and 2) to define the effect of plasma fluorination of YSZ monolithic occlusal veneers and regular crowns that have non-retentive designs on the bond strength to resin-based cements.

Methods: For objective 1, the YSZ blocks will be divided into
**Poster Abstracts**

four groups (n = 10/group) according to the surface treatment, as follows: control treatment (no surface treatment, as sintered), triboc- hemical treatment (silica-coating using 30 µm silica-coated alum inum oxide particles (Cojet), gas-fluorination treatment and a SixOy seed layer of 5 nm, and SixOy seed layer of 10 nm. YSZ blocks will be silanated and bonded to resin composite cylinders using a resin cement (Multilink Automix, Ivoclar Vivadent). The specimens will be stored in deionized water at 37 °C for a period of 24 h prior to bond testing. The bond strength will be calculated by dividing the fracture load by the cross-sectional area of the specimen. For objective 2, YSZ monolithic occlusal veneers and regular crowns (n = 90) will fit a CAD/CAM model of a prepared mandibular first molar. The bonding area of the tooth preparations will be scanned using a Cerec 3D camera and Cerec 3 Volume Program in order to calculate the nominal tensile strength after the test. Fifteen monolith- ic restorations of each type will not receive a surface treatment (control group); the other fifteen will receive the best fluorination treatment found for the cementation surface in aim 1. The remaining monolithic restorations will receive the tribochemo- treatment. The finished restorations will be cemented onto simulated tooth preparations made from Z100 (3M ESPE). The restorations will be subjected to bond strength test and dynamic fatigue (2 Hz x 10^4). Optical stereomicroscope and scanning electron microscopy will be used to evaluate the fracture surfaces and determine the failure mode. Two-way ANOVA (α = 0.05) and Tukey HSD multiple comparisons test will be used to determine statistical differences in bond strength among all groups. This project will allow new minimally invasive restorative approaches for instance for the rehabilitation of patients with moderate erosion, changes of the vertical dimension of occlusion, or short clinical crowns that derived from morphology.

**Acknowledgments:** Supported by the International College of Prosthodontists and the Biomedical Materials Science Shared Equipment Facility.

**Thermal Effect of the Laser Irrigation, Pulse Repetition and Time through a YSZ Ceramic**

*L Corby,* D Hutto; *J Griggs, S Salazar Marocho*

**Objectives:** Er,Cr:YSGG laser could serve as a fast and non-destruc- tive method for debonding yttrium-stabilized zirconia ceramics (YSZ), as long as the energy that will be transferred through the ceramic does not cause irreversible damage to the tooth pulp (> 42 °C). The aims were 1) to determine the maximum temperature (T) reached after laser irradiation through an YSZ ceramic in dry and wet conditions, and 2) to determine the effect of the time at different laser pulse rates (PPS).

**Methods:** Slices (~1 mm thick) were created from an YSZ block (IPS e.max ZirCAD, Ivoclar Vivadent), sintered in the Sintramat furnace, and divided into three groups (n = 30) according to the following PPS: 20, 30 and 45. Each group was tested in wet (W) and dry (D) conditions (W/20, W/30, W/45, D/20, D/30, D/45). Half of the samples were irradiated with 1% water and 1% air (W), and the other half were irradiated without water and air spray (D) using the Waterlase Biolase MD with an MG6 tip type. The T was recorded in Celsius (°C) at 1 watt with a digital thermometer (OMEGA HH506R) and a type K thermocouple at 30 s, 60 s, 90 s, and 120 s.

**Results:** Data are shown in the following table:

<table>
<thead>
<tr>
<th>Groups</th>
<th>Temperature (T) in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>After 30s</td>
</tr>
<tr>
<td>D/20</td>
<td>59.4 (2.6) d</td>
</tr>
<tr>
<td>D/30</td>
<td>52.9 (1.3) h</td>
</tr>
<tr>
<td>D/45</td>
<td>51.5 (1.2) l</td>
</tr>
<tr>
<td>W/20</td>
<td>21.3 (1.0) A</td>
</tr>
<tr>
<td>W/30</td>
<td>20.8 (1.9) A</td>
</tr>
<tr>
<td>W/45</td>
<td>20.2 (1.3) A</td>
</tr>
</tbody>
</table>

The same lowercase letters suggest no significant difference found among the D groups. The same uppercase letters suggest no significant difference found among the W groups.

Two-way repeated measures ANOVA showed that PPS did not have a significant effect on T. There was a significant interactive effect (p < 0.001) for the D/W conditions and time. The heat transferred through the YSZ structure was lower in the wet condition than dry condition at every point in time. For dry conditions, all points in time had significantly different temperatures.

**Conclusions:** The lack of irradiation during the laser irradiation (groups D) increases the T through the YSZ structures. Even the lowest irradiation time at any frequency will potentially decrease the dental pulp cell viability in dry conditions.

**Acknowledgements:** International College of Prosthodontics Research grant, Biomedical Materials Science Shared Equipment Facility at School of Dentistry, and the Intramural Research Support Program at the School of Dentistry (Award #18-03).

**Fracture Toughness of Dental Ceramics: Challenges of the SEPB Method**

*K Jodha,* S Salazar Marocho; *J Griggs*
Objectives: Fracture toughness is an intrinsic material property not affected by the superficial and internal defects present in the material. It can be calculated using various methods such as precracked beam, chevron-notched beam, and surface crack in flexure (ASTM C1421). This study aimed to determine the fracture toughness of two widely used dental ceramics using the single edge precracked beam (SEPB) method (ISO 15732).

Methods: Eight rectangular beam specimens were prepared from blocks for each of two dental ceramic prosthetic materials: lithium disilicate glass-ceramic (e.max CAD, Ivoclar Vivadent) and yttria-stabilized tetragonal zirconia polycrystal (Y-TZP) (e.max ZirCAD, Ivoclar Vivadent). These specimens were subjected to crystallization and sintering processes, respectively, per manufacturer instructions. The specimens were polished to final dimensions of 4 mm width, 3 mm thickness, and ~29 mm length followed by the creation of a notch on the 4 mm face using a diamond disk. Specimens were placed in a precracking fixture with the notch on the tensile side and loaded at a rate of 300 N/s until a pop-in sound was detected using a stethoscope. The precracked specimens were subjected to 4-point bending in water at room temperature at 9.3 N/s until completely fractured. The load at fracture was also recorded. Fractured specimens were examined under the scanning electron microscope (Supra 40, Zeiss, USA), and the average length of precrack was measured followed by fracture toughness calculation according to ISO 15732.

Results: The mean fracture toughness of lithium disilicate glass-ceramic was calculated as 2.09 ± 0.04 MPa•m$^{1/2}$. Lithium disilicate specimens that had too large of precracks were rejected (n = 4). For the Y-TZP group, 7 out of 8 specimens were rejected because of the following reasons: complete fracture during precracking (n = 3), too large of a precrack (n = 1), and no pop-in sound until 22 kN load (n = 3).

Conclusions: The SEPB method produces sharp precracks, but it is difficult to produce a stable precrack consistently across the specimens making it an impractical and unpredictable method for calculating the fracture toughness of the material, especially in the case of Y-TZP ceramic. Another method should be used for fracture toughness determination of Y-TZP ceramic.

Acknowledgments: The authors would like to acknowledge Mr. Joseph A. Thomas and Mr. David T. Owens for their help in preparing the precracking fixture. Research reported in this publication was supported by the NIDCR of the National Institutes of Health under award number R01DE024333. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Photocatalytic Activity and Antibacterial Efficacy of UVA-Treated Titanium Oxides

H Johnson$^1$, A Janorkar$^1$, M Marquart$^1$, R Williamson$^1$, M Roach$^1$

$^1$Department of Biomedical Materials Science, University of Mississippi Medical Center; $^2$Department of Microbiology and Immunology, University of Mississippi Medical Center

Objectives: Recent studies have shown UVA irradiation of titanium oxides may lead to photocatalytic activation (PCA) and produce reactive oxygen species (ROS). ROS have shown a bactericidal effect via damage to DNA or RNA or the rupture of cell membranes. Titanium oxide PCA has also been shown to accelerate the degradation of organic dyes, such as methylene blue (MB). Recent studies have attempted to use organic dye degradation generated through PCA as a predictor for bactericidal activity. However, there is still some disagreement on which titanium oxide phase or phase combination produces the greatest PCA. The objectives of the current study were to compare the PCA generated MB degradation for a variety of titanium oxide phase combinations and compare the results of antibacterial efficacy against Escherichia coli (E. coli).

Methods: 12.7 mm diameter commercially pure titanium grade 4 (CPTi) bar stock was cut into 2 mm thick discs and anodized in three electrolytes: A, B, and C. Oxide phases on the anodized surfaces were determined using thin-film X-ray diffraction (XRD). The PCA of each anodized surface and non-anodized CPTi controls (n = 8) was measured via degradation of 2 mL of a 0.001% MB solution under 20 W UVA (365 nm) LED light (~23 mW/cm$^2$) irradiation for selected time points up to four hours. One-way ANOVA ($\alpha = 0.05$) with post hoc Tukey analysis was used to determine significant differences in MB degradation at selected irradiation times. To evaluate antibacterial efficacy, discs were incubated with 104 colony forming units (CFU) of E. coli for 18 h. After incubation, discs were exposed to UVA irradiation for 1 h. Duplicate samples were covered with foil and kept in the dark to serve as controls. Following irradiation, bacteria were removed from the discs and serially diluted for CFU counting.

Results: XRD revealed the anodized surfaces produced in the three electrolytes to be primarily anatase phase (A), rutile phase (B), and an anatase/rutile mixture (C). All anodized surfaces exhibited statistically significant MB degradation compared to CPTi controls after 1 h. However, C surfaces also achieved significantly more degradation than A and B surfaces. After 1 h of UVA irradiation, the surfaces achieved bacterial reductions of 93% (CPTi), 95% (A), 99% (B), and 98% (C).
**Poster Abstracts**

**Conclusions:** The mixed phase oxide of C achieved more MB degradation than the single phase oxides of A and B as early as 1 h of UVA irradiation. All surfaces showed similar bacterial reduction after 1 h of UVA irradiation. However, B and C promoted more initial bacterial attachment, which resulted in higher killing efficiencies. Further research is ongoing on the bacterial efficacy of the anodized coatings against additional commonly acquired bacterial species to determine their susceptibility to titanium oxide PCA.

**Fractal Surface Analysis Using Surface Profilers and Mechanical Sectioning**

*K Kaur, K Jodha, S Salazar Marocho, Y Duan, J Griggs*

1Department of Biomedical Materials Science, University of Mississippi Medical Center

**Objectives:** To compare the fractal dimensional increment values (D*) of fractured yttria-stabilized tetragonal zirconia polycrystal specimens (Y-TZP, IPS e.max ZirCAD, Ivoclar Vivadent) using surface profilers, an atomic force microscope (AFM) and a mechanical profilometer, and compare the findings with those of the mechanical sectioning method.

**Methods:** Seven rectangular beam specimens of Y-TZP were prepared and subjected to a three-point bending strength test under water. An impression of the holey region of the fractured surface was taken using light-bodied polyvinyl siloxane (Extrude, Kerr) and poured in low-viscosity, low-shrinkage epoxy (EpoxySet, Allied High Tech). The epoxy replica, representative of the fractured surface was captured using an AFM (Bioscope Catalyst, Bruker), and a mechanical profilometer (Talyscan 150, Taylor Hobson Precision). Both the laser and contact mode of the profilometer were used. A custom MathCAD script was used to translate the captured images from each specimen into the FRACTALS software (Russ). The Minkowski Cover algorithm was used to determine the D* values. As a result of the disparity in the D* values obtained from either equipment, an alternate approach utilizing the mechanical sectioning method was performed. The epoxy replicas obtained from the seven Y-TZP specimens were sputter-coated with gold-palladium and poured in a subsequent layer of epoxy to form sandwich type specimens. Each specimen was polished parallel to the fracture surface starting with diamond lapping films from 35 µm to 6 µm until slit islands started to appear. Slit island coastlines were viewed under digital microscope (Keyence VH-Z100R). The Richardson algorithm was performed to measure boundary lengths between two designated points using eight ruler lengths of 6, 5, 4, 3, 2, 1, 0.6, and 0.4 cm. A log-log graph of total length vs step length was plotted, and the D* was calculated using the slope. One-way repeated measures ANOVA followed by Tukey’s HSD was used to identify significant differences.

**Results:** The D* values from the AFM and mechanical sectioning method showed no statistically significant difference. Similarly, the laser and contact modes of the mechanical profilometer showed no significant difference in data, but when the data from each of the modes was compared with the AFM and mechanical sectioning a statistically significant difference was seen.

**Conclusions:** The AFM shows the highest precision since it shows the least standard deviation among the D* values of the seven specimens, whereas the laser mode of the profilometer was shown to have the least precision.

**Acknowledgements:** Research reported in this publication was supported by the NIDCR of the National Institutes of Health under award number R01DE024333. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

**Roughness and Flexural Strength of a Zirconia Reinforced Lithium-Silicate Ceramic**

*A Oliveira, B Pereira, A Gomes, R Prado, R Melo, G Galhano*

1University of Western São Paulo, Presidente Prudente, SP, Brazil; 2São Paulo State University, São José dos Campos, SP, Brazil

**Objectives:** To evaluate the surface roughness and biaxial flexural strength of a zirconia reinforced lithium-silicate ceramic (Suprinity*, Vita) subjected to different forms of polishing.

**Methods:** Eighty disc shaped specimens of 12 mm diameter and 1.5 mm thickness were prepared from Suprinity* (Vita) blocks. The disc surfaces were finished with 400 grit silicon carbide (SiC) abrasive polishing discs (Struers) followed by 600, 800, 1000 and 1200 grit SiC discs under intense water cooling. The ceramic disks were divided in eight groups (n = 10) according to the surface treatment: 1) Control: no treatment; 2) F: roughening with diamond drill 3098F, simulating occlusal adjustment without polishing; 3) FGl: roughening with diamond drill 3098F + application of glaze; 4) FPol: fine diamond bur 3098F + SHOFU system + felt disk + diamond paste; 5) F+FPol: fine diamond bur 3098FF + extra fine diamond bur 3098FF + polishing; 6) FFPol: extra fine diamond bur 3098FF + polishing; 7) FF: adjust with a fine diamond bur 3098F only; 8) FFGl: roughening with extra fine dia-mond bur 3098FF + application of glaze. The surface roughness was measured for all groups prior to subject the ceramics discs to biaxial flexural test in a universal test ma-chine (Emic).

**Results:** According to the Shapiro-Wilk test at 5% significance, higher surface roughness was observed for the groups where the fine diamond bur F was used, with or without glaze application. When the extra fine diamond bur FF was used, the surface roughness
Poster Abstracts

values were similar to that of FGI and FFGI groups. Control, FGI and FFGI groups showed higher and similar flexural strength values.

Conclusions: The use of diamond tips increased the surface roughness and decreased the biaxial flexural strength of the Suprinity ceramic, regardless the type of the diamond bur (F or FF).

Acknowledgments: This work was funded by São Paulo Research Foundation (FAPESP) through scientific initiation grants by the process 2017/05502-5.

Drug-loaded Elastin-like Polypeptide-collagen Composites for Bone Tissue Engineering

P Pal1, Q Nguyen1, A Janorkar1

1Department of Biomedical Materials Science, University of Mississippi Medical Center

Objectives: Hydrogels are hydrated three-dimensional polymeric networks with native tissue microenvironment mimicking architecture. Hydrogel stiffness plays significant role in determining the differentiation of encapsulated stem cells towards certain lineage. Here we report development of osteogenic protein, rhBMP-2 and antibiotic, doxycycline loaded elastin-like polypeptide (ELP)-collagen composite hydrogels with mechanical properties suitable for osteogenesis.

Methods: Sample Preparation and Characterization: Eight different compositions of hydrogels were prepared by mixing collagen type I and ELP, with or without chemical cross-linking by NHS/ EDC and with or without doxycycline and rhBMP-2. The hydrogels were characterized by scanning electron microscopy (SEM), swelling ratio and FTIR. Uniaxial compression testing was used to measure the strength of hydrogels.

Cell culture to evaluate biocompatibility: The hydrogels were cultured with human adipose derived stem cells (hASC) and supplemented with osteogenic media to evaluate the differentiation potentiality of the hydrogels. Live/dead and Rhodamine/DAPI (Thermo Fisher) assays were performed at days 7 and 21. DNA quantification (CyQUANT™, Thermo Fisher), total protein content (Thermo Fisher), alizarin red assay (EMD Millipore) and alkaline phosphatase assay (BioAssay Systems) were performed on days 0, 7, 14, and 21. All assays were performed using manufacturers’ recommended protocols.

Results: Microscopic observation of the freeze-dried hydrogels using SEM revealed that the hydrogels had three-dimensional interconnected open structure. Among all hydrogel compositions used, the doxycycline and rhBMP-2 loaded ELP-collagen hydrogels, with and without cross-linking exhibited maximum compressive strength of ~25 kPa which was desirable for differentiation of stem cells towards osteogenic lineage. Upon culturing stem cells in these hydrogels, the characteristics of osteogenic differentiation, namely the ALP expression, osteocalcin expression, and alizarin red stain quantification, were significantly higher for drug-loaded hydrogels compared to hydrogels without drugs. Previously, we have shown that the drug loaded composites were able to release an effective dose of doxycycline against three bacteria strains that are commonly encountered in clinical settings, namely, E. coli, P sanguinis, and MRSA.

Conclusions: Taken together, the doxycycline and rhBMP-2 loaded ELP-collagen hydrogels show higher osteogenic differentiation potential of stem cells along with suitable antibacterial properties and thus will be effective in bone tissue engineering applications.

Acknowledgements: Research reported in this publication was supported by the NIDCR of the National Institutes of Health under award number R03DE024257. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. Also supported by the UMMC and School of Dentistry Intramural Research Support Programs.

Porosity Effects on the Biocompatibility of PEEK and Titanium-6Aluminum-4Vanadium

K Nobles1, P Pal1, A Janorkar1, R Williamson1

1Department of Biomedical Materials Science, University of Mississippi Medical Center

Objectives: Integration of implants with bone is crucial for implant device success, and insufficient integration is a major cause of implant failure. This direct contact between bone and implant surfaces is known as osseointegration. Surface properties such as morphology, chemistry, and roughness are thought to affect how implants interact with bone cells. Studies have shown that materials with porous surface morphologies can improve cell adhesion, differentiation, and spreading. In this study, polyetheretherketone (PEEK) and Titanium-6Aluminum-4Vanadium (TAV) were evaluated for their effect on the adhesion, differentiation, and proliferation of pre-osteoblastic cells.

Methods: A total of 96 PEEK and TAV samples with 1/2” diameter and 2-3 mm thickness were obtained from Zavation, LLC. The sample types were solid surface TAV, porous through-out TAV, solid surface PEEK, and surface porous PEEK. The samples were split into four groups which represented the following time points: day 1, 7, 14, and 21. MC3T3-E1 mouse pre-osteoblastic cells were seeded onto each sample at a concentration of 30,000 cells/sample. The cell-seeded samples were
Poster Abstracts

incubated, and had media changed and supplemented with osteogenic inducing media every 48 hours. At each time point, cell collection was performed and, after the day 21 time point, biochemical characterization assays and imaging were performed. Live/dead, rhodamine/DAPI, and Alizarin Red staining techniques were used to image the samples. Various assays were used to measure total protein and DNA content, ALP activity, and osteocalcin activity.

Results: DNA and protein concentration for each sample were relatively close in value at each time point with slight increases in each. The ALP and osteocalcin activity data also showed similar values for each sample at each time point, however, the values appear to be decreasing at time points where the values are increasing in the ALP and protein data, and vice versa. The Alizarin Red data shows evidence of osteoblast mineralization for the surface porous PEEK, solid PEEK, and porous TAV materials at the day 21 time point. The general trend of the data showed that the solid TAV samples showed the most cell proliferation with less osteoblast differentiation, while the other samples showed less cell proliferation and more osteoblast differentiation, maturation, and mineralization.

Conclusions: All sample material types were biocompatible in vitro and promoted cell proliferation. The TAV and PEEK porous samples showed a trend of higher osteoblast mineralization compared to the solid surface materials. However, a greater sample number will need to be tested in the future to determine if this is statistically significant. Also, surface characterization of the samples will need to be evaluated to determine roughness, chemistry, or other surface porosity effects.

Acknowledgements: Supported by a grant from Zavation, LLC.

Microstructural Characterization of a Dental Nano-composite

M Satpathy, J Grigg

1Department of Biomedical Materials Science, University of Mississippi Medical Center

Objectives: In recent years, there has been a focus to develop low shrinkage dental composites. The aim of this study was to verify the microstructure, elemental composition and volume fraction of a novel dental nanocomposite incorporated with ultra-fine silanized fluoride-releasing fillers.

Methods: The specimens were prepared by light-activated curing of a monomer matrix of the following purported composition (wt%): 40% BisGMA, 40% EBPADMA, and 20% HDDMA plus 75% of an ultra-fine silanized fluoride-releasing filler. The fracture surface of one specimen was gold-coated, and the disk-shaped specimen was polished to a 0.1 µm surface finish and was carbon-coated. Both the specimens were examined under SEM and EDS. Five polished sections were examined by stereology grids.

Results: It was observed that the filler particles varied in size up to 1.8 µm and were incorporated well into the polymer matrix with no porosity at their surfaces. EDS data showed the presence of about (mol%) 11% silicon, 3-5% fluorine, 3% barium, 2-3% aluminum, 35-43% carbon and 38-43% oxygen in all filler particles. Stereology estimated the filler volume fraction to be 64% ± 4%.

Conclusions: The EDS data confirmed the presence of silicon, fluorine and barium within the samples. Silicon is essential for holding the glass network together within the composite, and barium makes it radio-opaque. Fluoride increases chemical resistance and reduces tooth sensitivity. The presence of gold peaks can be attributed to the gold coating of the rectangular specimen. It was confirmed that only one type of particle was present in the composites. The composition was typical for a dental composite, and the volume fraction of fillers was as purported by the manufacturer.

Acknowledgements: Supported by Dr. Xiaoming Xu from Louisiana State University Health Sciences Center (LSUHSC).

Influence of the Type of Antagonist Piston Material on Fatigue Behavior of a Glass-ceramic

K Weber, D Meneguetti, P Benetti, J Grigg, M Borba

1Post-graduate Program in Dentistry, University of Passo Fundo; 2Department of Biomedical Materials Science, University of Mississippi Medical Center

Objectives: It is important for in vitro studies to adequately simulate the conditions to which dental restorations are subjected clinically so the data can be safely extrapolated for clinical use. The stiffness of the antagonist may affect the results. Thus, the objective of the study was to assess the effect of antagonist piston material on the fatigue behavior of a glass-ceramic.

Methods: Plate-shaped specimens of lithium disilicate-based glass-ceramic (1.2 mm thick) were adhesively cemented onto a dentin analogue substrate. The specimens were divided into three groups according to the piston material (n = 30): (M) metal (stainless steel), (R) composite (NEMA-G10, fiber-reinforced epoxy resin), (C) ceramic (lithium disilicate-based glass-ceramic). Fatigue testing was performed using a mechanical cycling machine with 2 Hz frequency in 37 °C distilled water. Load was applied in axial compression perpendicular to the ceramic surface. Two lifetimes were evaluated (100,000 and 500,000 cycles), and the load amplitude was defined according to the boundary technique (63 - 90 N). Fatigue data were analyzed using Weibull distribution and an inverse power law lifetime relation (ALTA PRO, Reliasoft). Failure mode was analyzed using transillumination and classified as either radial or cone cracks.

Results: Group R had a significant higher value of crack growth exponent (n) than groups M and C, meaning that the failure probability (Pf) of specimens tested with R piston was more dependent on load amplitude (Figure 1). Therefore, when the Pf (%) was estimated for lower loads, such as 30 N and 60 N (100,000 and 500,000 cycles), specimens tested with R piston showed lower Pf (%) than the ones tested with M and C pistons. Yet, when estimations were performed at a higher load (90 N) there was no difference among groups. Radial cracking was the predominant failure mode.

Conclusions: The type of antagonist piston material affected the fatigue behavior of the glass-ceramic. The probability of failure of specimens tested with the composite piston was more sensitive to the load level applied.
Acknowledgments: This study was partially supported by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES - Finance Code 001) and by the Conselho Nacional de Desenvolvimento Cientifico Tecnológico (CNPq, research grant no. 461178/2014-1).

Figure 1. Graphs of failure probability vs. time for 90 N, 60 N and 30 N load levels.

*Investigating the Role of Polymers in Anhydrobiosis*

**T Stamps**, J Cobb, P Pal, P Vig, A Janorkar

Tougaloo College; Department of Biomedical Materials Science, University of Mississippi Medical Center; Department of Neurology, University of Mississippi Medical Center

Objectives: Organ and tissue donations are essential to transplant patients who are in critical need of these vital parts. As soon as the organ is removed for transplant, it must be transplanted immediately or put on ice to maintain its viability for 4 up to 72 hours. While maintaining the viability of the organ, a patient must be found to match the organ. This presents a major issue for organs that need to be transported over prolonged distance. There have been many innovations to the process of preserving organs, but they all involve the process of cold storage. One possible approach to solve this issue is by incorporating the method of anhydrobiosis into organ preservation. Anhydrobiosis means “Life without water” and is a process used by certain organisms to preserve cells during desiccation. It is currently believed that certain molecules play an important part in anhydrobiosis by replacing the role of water in a cell. However, the number of molecules needed to preserve a mammalian cell is enough to kill it. A possible solution to this problem is to incorporate polymers into the system with the anhydrobiosis molecules to stabilize the cell membrane and hold on to a minute amount of water that the cell can use to maintain viability. This research has investigated the individual roles that the molecules and polymers play in anhydrobiosis by observing their behavior both inside and outside of a cell.

Methods: We utilized Fourier Transform-Infrared Spectroscopy to examine the wavelengths of the polymers and molecules to look for differences in their chemical structure. We observed different variations of our molecule by using Scanning Electron Microscopy to determine the best molecule that could have a polymer chemically attached to it. We cultured cells and incorporated our newly formed molecule into its structure which we viewed with Optical Fluorescent Microscopy.

Results: We found that we were able to penetrate the cellular membrane with our polymer and the molecule that could essentially preserve the cell. We dehydrated the cells by means of heating, dehydration, and desiccation. After heating, the cellular membrane was completely dismantled, and the cells liquefied leaving only hints of a cellular structure. Next, we dehydrated the cells by using 100% ethanol, but it was determined that the cells were affixed to the dish because of this method. Finally, we used heat to properly induce anhydrobiosis in the cells. The cellular integrity was still held post-heating and had the highest probability of success but failed to rehydrate.

Conclusions: We concluded that the cells were unable to rehydrate post-dehydration. Further studies must be completed on the organisms that can induce anhydrobiosis in order to better understand the ratios and specific polymers needed to induce anhydrobiosis in mammalian cells.

Acknowledgements: Mississippi INBRE.
Research Opportunities at the University of Mississippi School of Dentistry

Honors in Research Program

The Honors in Research Program (HRP) provides an opportunity for eligible dental students to choose advanced study in dental research or basic health science and receive recognition for their accomplishments on their transcripts and at graduation.

Honors work consists of hypothesis driven research in some aspect of dental or basic health science. Students conduct laboratory research, clinical research, or population research (e.g., improving current clinical practices, exploring controversies in dentistry, engaging in basic and biomedical materials research) with the guidance and supervision of a UMMC faculty member.

Honors in Research Graduates - 2009-2018
Jiman Nelson, Kendra Reed Clark, Jennifer Bain, Jason Brown, Reid Lester, Kristin Balius, Curtis Caskey, Lacey Harris, Stacey Ritter, Camille Sandifer, Corey Shook, Phebe Winters

School of Dentistry Intramural Research Support Program (IRSP)

The goal of the Intramural Research Support Program is to provide seed funding for research activities in the School of Dentistry. In addition to faculty, pre-doctoral students and residents who develop a faculty-mentored research project are eligible to apply for small grants to cover materials and supplies. Priority will be given to those research projects which involve School of Dentistry students.

Student Research Group (SRG)

The School of Dentistry Student Research Group is a branch of the American Association for Dental Research (AADR) National Student Research Group (NSRG) and is composed of dental and graduate students committed to research and the advancement of further education. Goals of the organization are to expose dental students to various student research projects, aid in the application process for residencies to dental specialties, and to encourage student participation in dental research. Meetings allow students to share and evaluate on-going research projects within the School of Dentistry.

Student Research Group Officers for 2018-2019
President – Kartikeya Jodha
Vice-President – Mary Linda Remley
Treasurer – Justina Boles
Secretary – Sarah Malley
Student Advocacy Representative - Ambika Srivastava
Faculty Advisor – Dr. Jennifer Bain

Student Research Group Officers with Dr. Bain
Student Research Opportunities at the University of Mississippi School of Dentistry

Undergraduate and Professional Student Training in Advanced Research Techniques (UPSTART) Program

The UPSTART Program provides an opportunity for eligible dental, pre-dental, pre-graduate, and high school students to be involved and trained in research at the University of Mississippi School of Dentistry. The program is designed to initiate students in research by pairing with research mentors, teaching general laboratory safety, and instilling essential research skills through hands-on learning. The research experience is provided under the mentorship of a dental faculty member who is actively engaged in research throughout the summer. The program promotes learning of the dental students as well as the undergraduate students from national colleges and universities in design and successful implementation of research projects through a didactic seminar series, hands-on laboratory research, and peer-judged research presentations. The students have the opportunity to present their research findings as an oral seminar in the “UPSTART Symposium” organized at the end of the UPSTART program. Additionally, the students are expected to present the research performed during the UPSTART program and progress since then on the following School of Dentistry Research Day. Since its inception, 139 students (68 dental, 71 other) have benefited from this program.

For information contact:
Dr. Amol V. Janorkar (Email: ajanorkar@umc.edu / Phone: 601-984-6170)
2018 AADR/Dentsply Sirona Student Clinician Research Award - Quynh (Jolie) Nguyen was the AADR/Dentsply Sirona Student Clinician Research Award winner and was presented the award at Student Awards Day 2018. She will attend the annual SCADA Award Program and Reception, which is held during the AADR Annual Session.

2018 American Association for Dental Research (AADR) Award - Scarlett Woods was presented this award for making the best presentation at the annual SOD Research Day. Woods will receive travel funding to attend the annual AADR conference and represent her school in the student competition there.

2018 Hinman Student Research Award – Sarah Malley received this award and represented UMMC at the Hinman Student Research Symposium in Memphis, TN on November 2 - 4, 2018 at the historic Peabody Hotel.

Omicron Kappa Upsilon (OKU) Research Award of Excellence – The OKU Research Award of Excellence is presented to the dental student who makes the finest presentation at the annual SOD Research Day. This award comes with a $250 cash prize that is sponsored by the Omicron Kappa Upsilon dental honor society. The 2018 winner of this award was Scarlett Woods.

2018 Quintessence Award for Research Achievement – Jiman Nelson received the School of Dentistry Quintessence Award for Research at the SOD Awards Day on April 17, 2018. Nelson received this honor for his many combined achievements in research during his time in the DMD program. Nelson was chosen to represent the School of Dentistry at the ADA Colgate Dental Student’s Research Conference in Washington, DC in both 2015 and 2017. He received 2nd place in the research poster competition at the Student National Dental Association (SNDA) annual conference in 2016. Also in 2016, Nelson won the Hinman Dental Student Research Award and presented his research at the Hinman Student Research Competition in Memphis, TN. In 2017, Nelson was the ADA/DENTSPLY Student Research Award recipient and presented his research at the AADR Conference in Ft. Lauderdale, FL. Nelson also received the Alliance of the Mississippi Dental Association Award in 2017 based upon performing community service and his commitment to promoting dental education. In 2018, Nelson received the Academy of Dental Materials Award for excellence in scholarship in dental materials while pursuing dental studies. Nelson capped off his dental student career by graduating with Honors in Research in 2018.

Graduate Student Receives ADM Award - Kartikeya Jodha, a Ph.D. student in the biomedical materials science department, received the Student Travel Award for the North American region by the Academy of Dental Materials. The ADM offers the award in recognition of excellence in dental biomaterials research. The primary purpose of the award is to encourage and recognize outstanding research by students currently enrolled in education programs in areas relevant to the ADM’s mission. The award pays for registration and $1,000 towards travel to the annual international conference, which took place from October 4-6 in Porto de Galinhas, State of Pernambuco, Brazil.

The National Institutes of Health Medical Research Scholars Program - Quynh (Jolie) Nguyen, a fourth-year dental student, was selected to take part in the NIH’s 12-month Medical Research Scholars Program. This research training program allows medical, dental and veterinary students to take a one-year hiatus from their university studies to conduct basic, clinical or translational research at the NIH’s intramural campus in Bethesda, Maryland. Nguyen was selected from among 115 applicants during the 2018-19 application cycle. She will take part in mentored training and will conduct research in areas that are of personal interest to her.

2018 LeRoy Wyman Award – Dr. Michael Roach, associate professor of biomedical materials science, was selected by the Committee F04 on Medical and Surgical Materials and Devices to receive the 2018 LeRoy Wyman Award from the American Society of Testing and Materials (ASTM). Roach received the award at the society’s May 23 meeting in San Diego, California. ASTM International is a globally recognized leader in the development and delivery of voluntary consensus standards. The Wyman Award is presented to engineers and material scientists who have served with distinction on the committee and have proven evidence of leadership and significant contributions. Roach’s laboratory is one of only two academic labs in the United States with ISO 17025 certification, the international standard for testing and calibration laboratories.

2018 Excellence in Research Award - Dr. Amol Janorkar, professor in the Department of Biomedical Materials Science, received the Gold Medallion for research excellence at the Excellence in Research Awards Ceremony on October 24, 2018. The Excellence in Research Awards Program recognizes UMMC investigators who have attracted significant extramural funding and who have advanced science through their distinctive research programs. Medallion Awards are based on the total amount of extramural funding received by the investigator for his/her original research. The Gold-level Medallion is for $1,000,000 in total extramural funding.
Faculty Excellence in Research (as of December 31, 2018)

**Cumulative Publications**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Name</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>David Felton</td>
<td>110</td>
</tr>
<tr>
<td>2</td>
<td>Jason Griggs</td>
<td>67</td>
</tr>
<tr>
<td>3</td>
<td>Amol Janorkar</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>Christopher Hughes</td>
<td>42</td>
</tr>
<tr>
<td>5</td>
<td>Yuanyuan Duan</td>
<td>41</td>
</tr>
<tr>
<td>6</td>
<td>Michael Roach</td>
<td>32</td>
</tr>
<tr>
<td>7</td>
<td>Niping Wang</td>
<td>24</td>
</tr>
<tr>
<td>8</td>
<td>Ahmad Abdelkarim</td>
<td>21</td>
</tr>
<tr>
<td>8</td>
<td><strong>Scott Williamson</strong></td>
<td>21</td>
</tr>
<tr>
<td>9</td>
<td>William Buchanan</td>
<td>19</td>
</tr>
<tr>
<td>9</td>
<td>Tracy Dellinger</td>
<td>19</td>
</tr>
</tbody>
</table>

**Cumulative Hirsch-Index**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Name</th>
<th>H-Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>David Felton</td>
<td>28</td>
</tr>
<tr>
<td>2</td>
<td>Christopher Hughes</td>
<td>23</td>
</tr>
<tr>
<td>3</td>
<td>Jason Griggs</td>
<td>21</td>
</tr>
<tr>
<td>4</td>
<td>Amol Janorkar</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>William Buchannan</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td><strong>Jennifer Bain</strong></td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>Tracy Dellinger</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>Yuanyuan Duan</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>Ron Caloss</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Niping Wang</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Harold Livingston</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td><strong>Susana Salazar Marocho</strong></td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>Michael Roach</td>
<td>7</td>
</tr>
</tbody>
</table>

**Annual Publications**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Name</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jason Griggs</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>Amol Janorkar</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Yuanyuan Duan</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Ahmad Abdelkarim</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Michael Roach</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td><strong>Scott Williamson</strong></td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Tina Woods</td>
<td>2</td>
</tr>
</tbody>
</table>

**UPSTART Student Mentoring (2008-2018)**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Name</th>
<th>DMD</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Amol Janorkar</td>
<td>12</td>
<td>33</td>
</tr>
<tr>
<td>2</td>
<td>Michael Roach</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>Jason Griggs</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>Yuanyuan Duan</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td><strong>Susana Salazar Marocho</strong></td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Scott Williamson</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>Mitch Hutto</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Steve Magee</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>Ron Caloss</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

**Bold print** signifies an NIH Early Stage Investigator

---

Ph.D. Students with Dr. Jack Lemons
Research Day 2018...