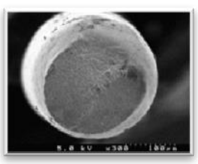
(1) *Fatigue of dental archwires*

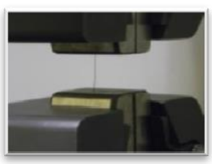
Shape memory alloys (SMA) have had a tremendous effect on the advancement of orthodontic treatment by providing excellent strain recovery, constant gentle forces, and lower stiffness than traditional stainless steel archwires. Furthermore, the development of nickel-free material systems has provided patients with a suitable option for orthodontic treatment that eliminates the concern of nickel sensitivity present with Nitinol shape memory systems. The current work investigates the strain-life behavior exhibited in Nitinol, beta titanium and stainless steel archwires in fully-reversed, flex bending fatigue. The arch wires are evaluated in low cycle fatigue (LCF) and high cycle fatigue (HCF) regimes. The effects of composition, wire diameter, and material microcleanliness on the respective mechanical behavior are under investigation.

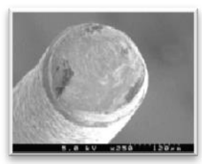
Arch wire *Arch wire under flex bending*

(2) *Characterization of fine wires used in biomedical applications and reliability of stranded and coiled systems*

Metallic fine wires are used frequently in medical devices particularly due to the advent of minimally invasive surgeries. The wires may be used alone or in combination to form strand or coil architectures. The reliability of these wires is paramount to the success of the treatment modalities in addition to the wire/component interfaces present in implantable electrode systems and therefore requires stringent mechanical evaluation. Current research interests include the mechanical characterization of Nitinol, DFT-MP35N/Ag, and 316 LVM stainless steel wires. Static and fatigue testing of fine wires representing a variety of process treatments ranging from various oxides (Nitinol), heat treatments, effects of laser machining on the wires, and material microcleanliness are under investigation. Mechanical tests of interest include uniaxial tension, flex bending fatigue, rotating bending fatigue, axial fatigue, and crushing.





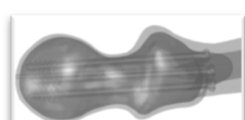


Annealed 316 LVM under tension[1] *Annealed 316 LVM under rotating bending*[1]

[1] *Gbur, J. L. (2013) Mechanical characterization of 316 LVM wires: A comparative study of flex bending fatigue and rotating bending fatigue and its utility in fatigue testing for biomedical applications, ASTM Student Grant Paper.*

(3) *Evaluation of composite bone following removal of hardware from hip fixation techniques*

Hip fracture treatments vary in the amount of bone removed in order to apply appropriate hardware and reduce the fracture(s). Upon healing, surgeons may either remove the hardware or allow it to remain within the bone, each presenting a variety of advantages and disadvantages. Composite bone has emerged as a substitute for cadaveric bone in the determination of mechanical performance of implanted orthopaedic devices allowing for improvement in some forms of *in vitro* testing by minimizing specimen variability, reducing preparation concerns, and decreasing costs. Research interest focuses on developing test protocols that utilize composite bones for comparing fixation techniques and hardware. Development of computer simulations to augment and validate the physical testing and investigations of the effects related to declining bone density on the stability of the implants are areas of future interest.



Augmentation Composite femur with removed hardware Computer model