Materials Science and Engineering

Laser

Abstract
As manufacturers continue to pursue higher levels of quality and develop ever smaller products needs manufacturing methods are needed. The STM is at the head of nano-machining and the cost and quality of STM tips a limiting factor in its use. We've developed a process of laser annealing tungsten wire for the purpose of sharpening STM tips. This method will provide greater control and be more efficient over the current annealing method allowing the technology to advanced and mature.

Team members:
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Sponsors
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Dr. Nigel Shepherd

Acknowledgements:
CART, Zyvex Labs,

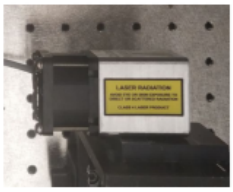
Laser Annealing Process Design: Tungsten Scanning Tunneling Microscope Tip

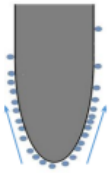
Processing Method

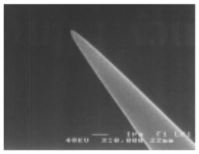
Old:
- Joule Heating: I^2R=P
- Energy Inefficient
- Damages Equipment
- Poor Temperature Control

New:
- Radiative Heating
- Energy Efficient
- Less Maintenance
- Precise Temperature Control

Laser Annealing
- 6W 445nm (Blue) Laser
- Optical Lenses for Increased Power Density
- >1000°C Objective Temperature
- Precision Targeting (End Only)

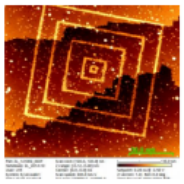




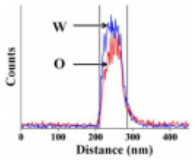


Tip Sharpening by Surface Diffusion
Atoms move away from tip due to added energy from laser.

Materials Characterization to Understand:
- Changes in Microstructure
- Changes in Chemistry



Application
By reducing the tip size below 2nm, STM tips can be used for nano-machining .



Optimization
By annealing in a vacuum, oxidation of the tungsten tip can be prevented.

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Young's Modulus

Abstract
A new NiTiSn low temperature shape memory alloy (SMA) has been designed to be implemented as an actuator for a deep space expandable habitat. This material shows potential to: 1) reduce the mass and cost, 2) increase the reliability and functionality of actuation devices in deep space conditions. Throughout this design process the site preference and solubility of Sn in NiTi was evaluated. The effects of Sn content, NiTi ratio, and precipitation strengthening on transformation temperature, phase composition, and mechanical properties in the NiTiSn SMA system were also assessed.

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Materials Science and Engineering

Self-Healing Ceramics Team

Abstract
Ceramics are easily susceptible to fracture due to their ability to create and propagate a crack under stress with little ability to blunt the crack. This creates immense environmental, health, and economic burden when ceramic applications, such as nuclear fuel cell cladding, fail, causing complete replacement of structure. In our design, we compared the self-healing methods of oxidation healing and silver-assisted healing of silicon carbide.
SiC was chosen for its ability to readily oxidize in open air furnaces and its ability to react with silver in the proposed self-healing method. At high temperatures, silver binds with silicon creating a liquid matrix that causes a quicker diffusion rate of the whole system. Consequently, this heals the crack by filling itself in through reduced interfacial tension between the silver-silicon matrix and the silicon-carbide matrix. As the system cools, silver will evaporate leaving silicon carbide to reform crack-free.

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Haley Barnes
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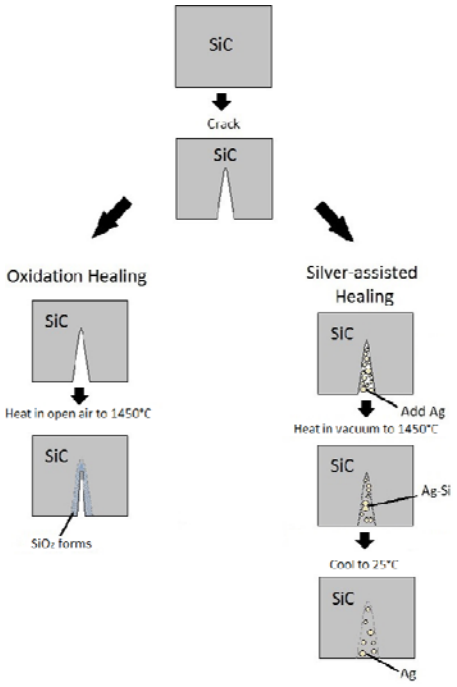

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Degredation Resistant High Entropy Alloys for Biomedical Applications

Abstract
High entropy alloys (HEA s) have been shown to have good corrosion and wear resistances, making them candidates for applications in medical implants. The corrosion and wear properties of three different compositions of a CoCrFeMnNi alloy, with varying amounts of chromium were tested. Different surface roughnesses and as-cast or cold worked and recrystallized variations of each alloy were also tested in order to design a CoCrFeMnNi alloy that maximizes corrosive and wear properties.

Team members:
Richard Clore
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Sundeep Mukherjee

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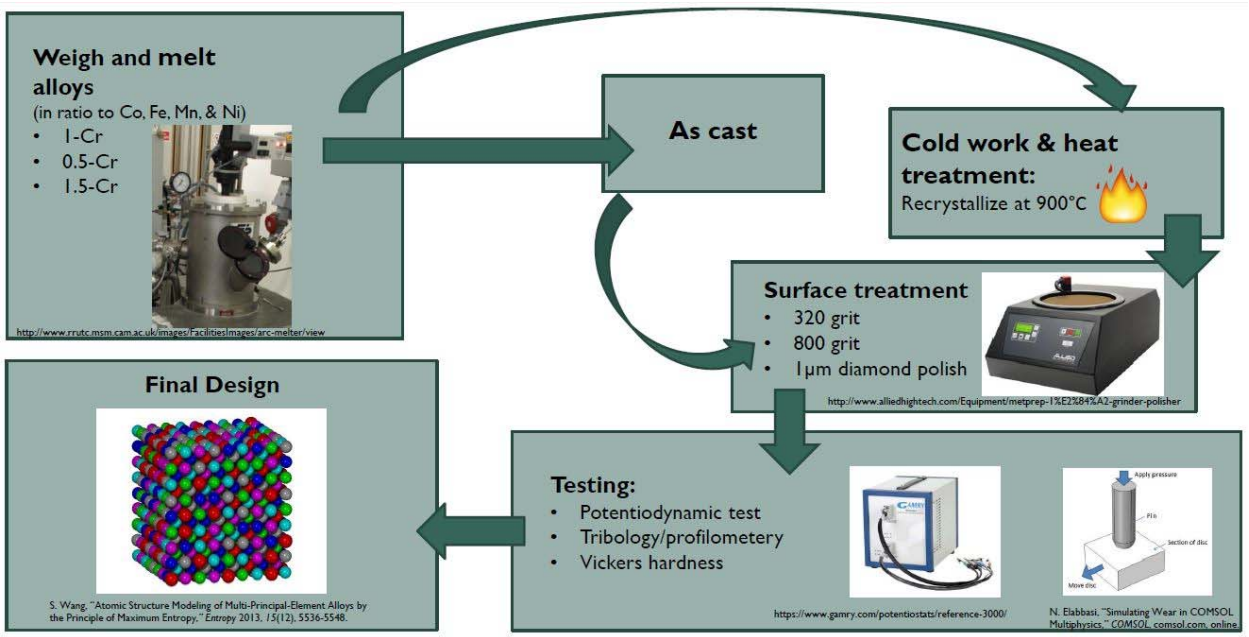

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Recycling PVC for metal wires and cables coatings

Abstract
Polyvinyl chloride (PVC) is one of the most used polymers in industry. There is an environmental contamination problem because as PVC degrades in landfills it releases toxic chemicals into the soil. We have incorporated recycled PVC into the electrical wire coating formula in order to reuse the material. We have found that by adding crosslinking agents and UV stabilizers to the recycled PVC mixture we have mitigated the deterioration of properties including tensile strength and the elongation at break. The best set of properties is seen in the 80% recycled PVC as it offers the best elongation properties which are important to the application since wire coatings must be able to bend without snapping and exposing the wire underneath. With the addition of recycled material the overall cost of the wire coating will be lower than using virgin PVC only while the rate of putting PVC waste into landfills would be mitigated.

Team members:
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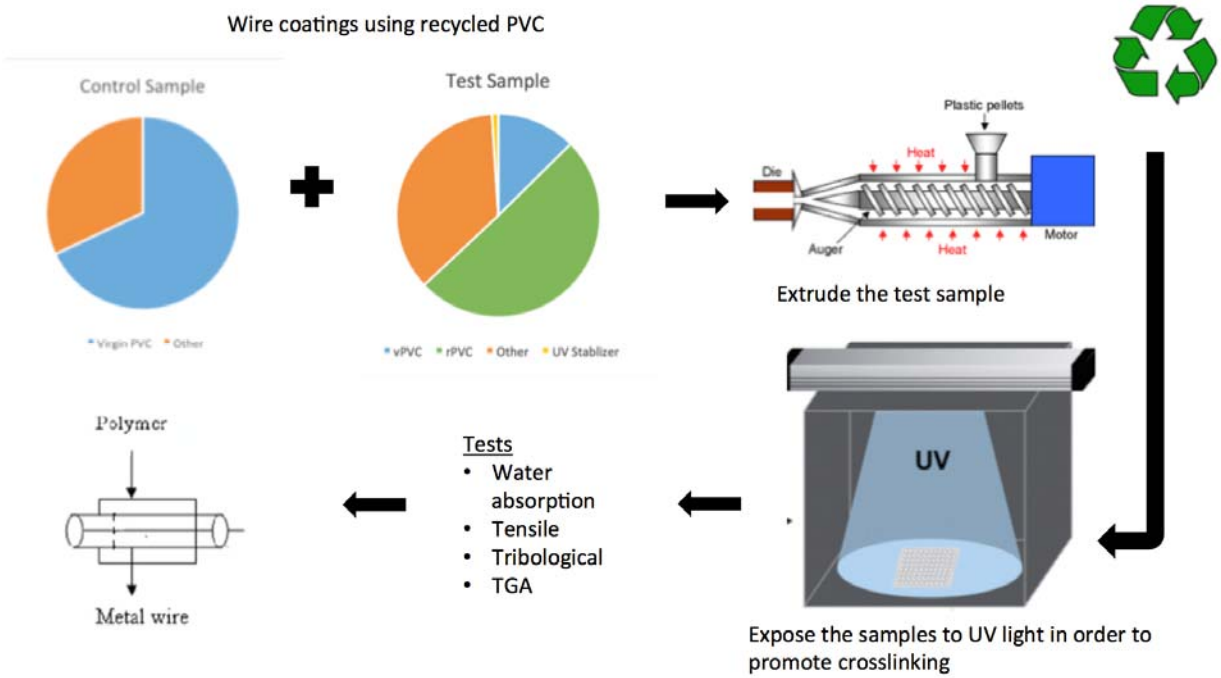

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Team Aqua

Abstract
A design has been proposed to detect degradation within a fiberglass pipe using an acoustic transducer. The transducer will find defects as an early warning to catastrophic failure. The acoustic transducer is contact based and is fed a voltage from a pulse generator to emit a wave and sends a signal to an oscilloscope from an interface reflected wave. Measurments will be periodically taken to document defect progression.

Team members:
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