CONFLUENT

Shot Peening Process Optimized for Nitinol Medical Devices

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Overview

Introduction

Shot Peening Basics

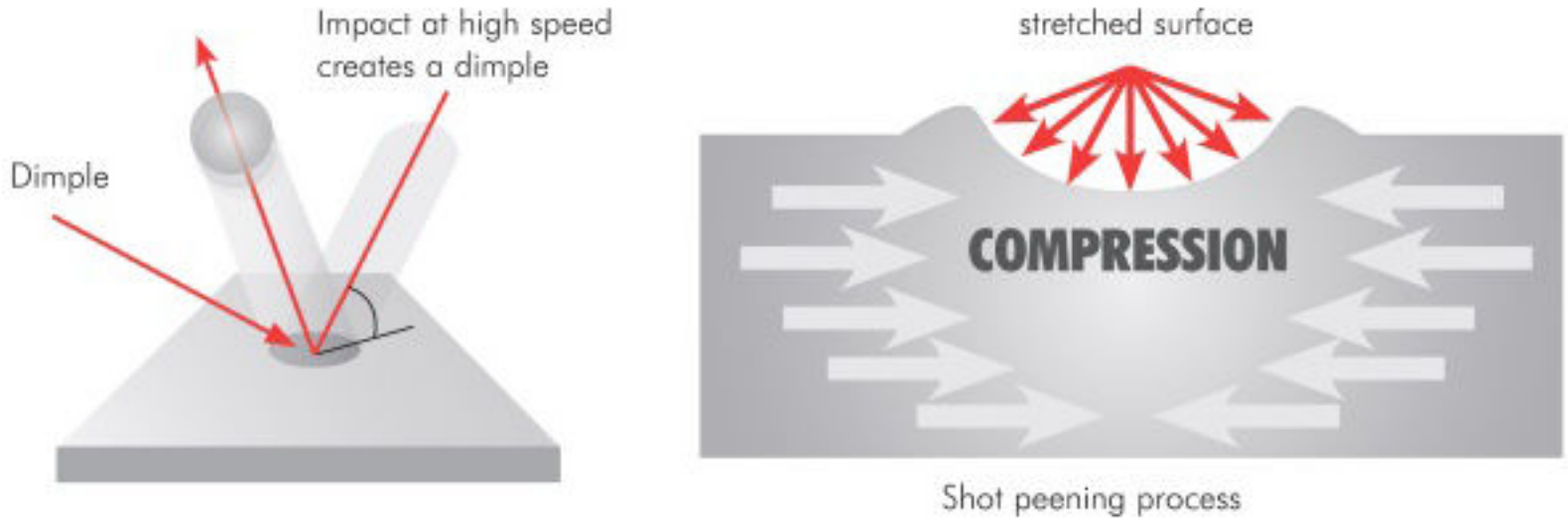
Our Experiment

Results

Conclusion

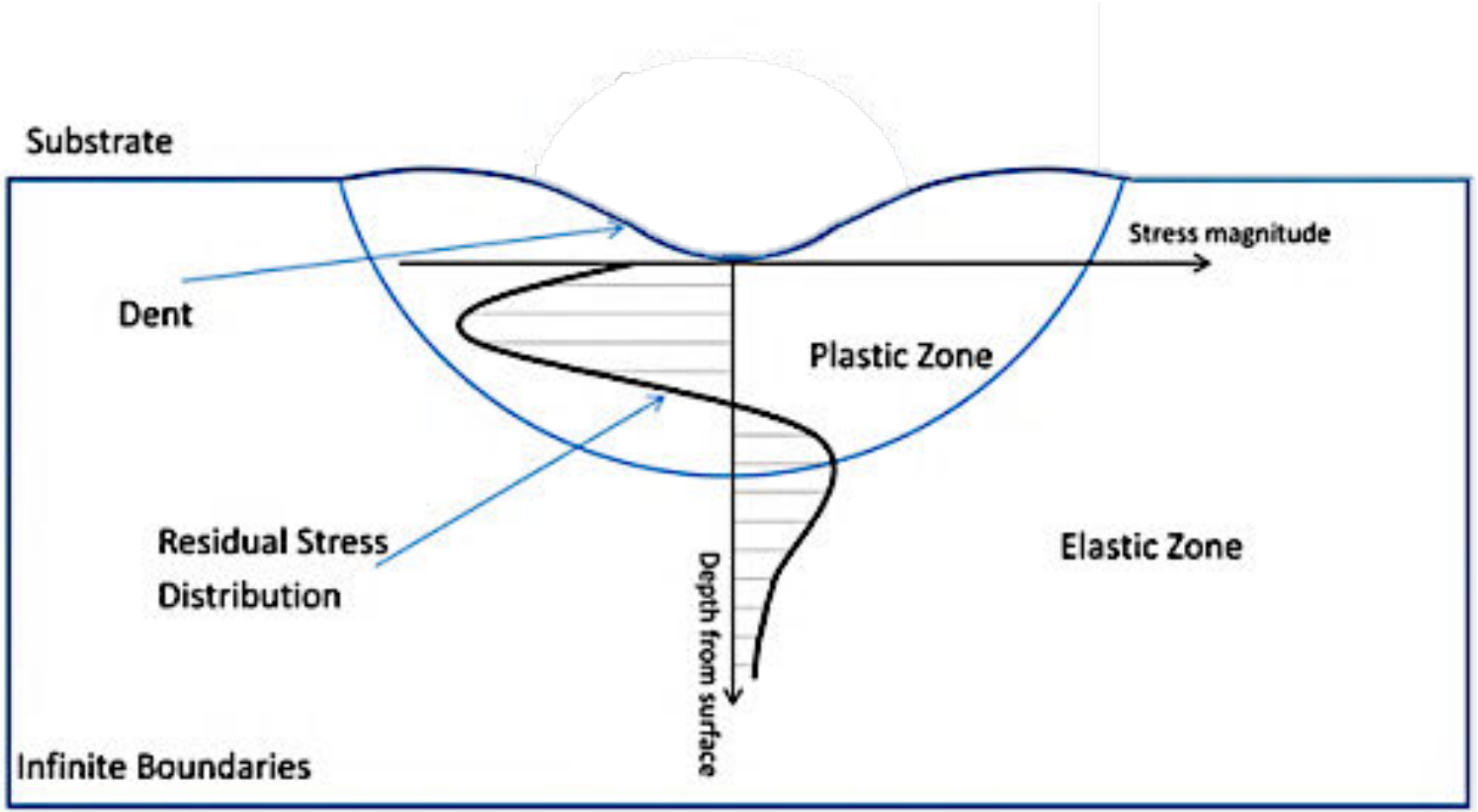
Questions

Shot Peening Basics

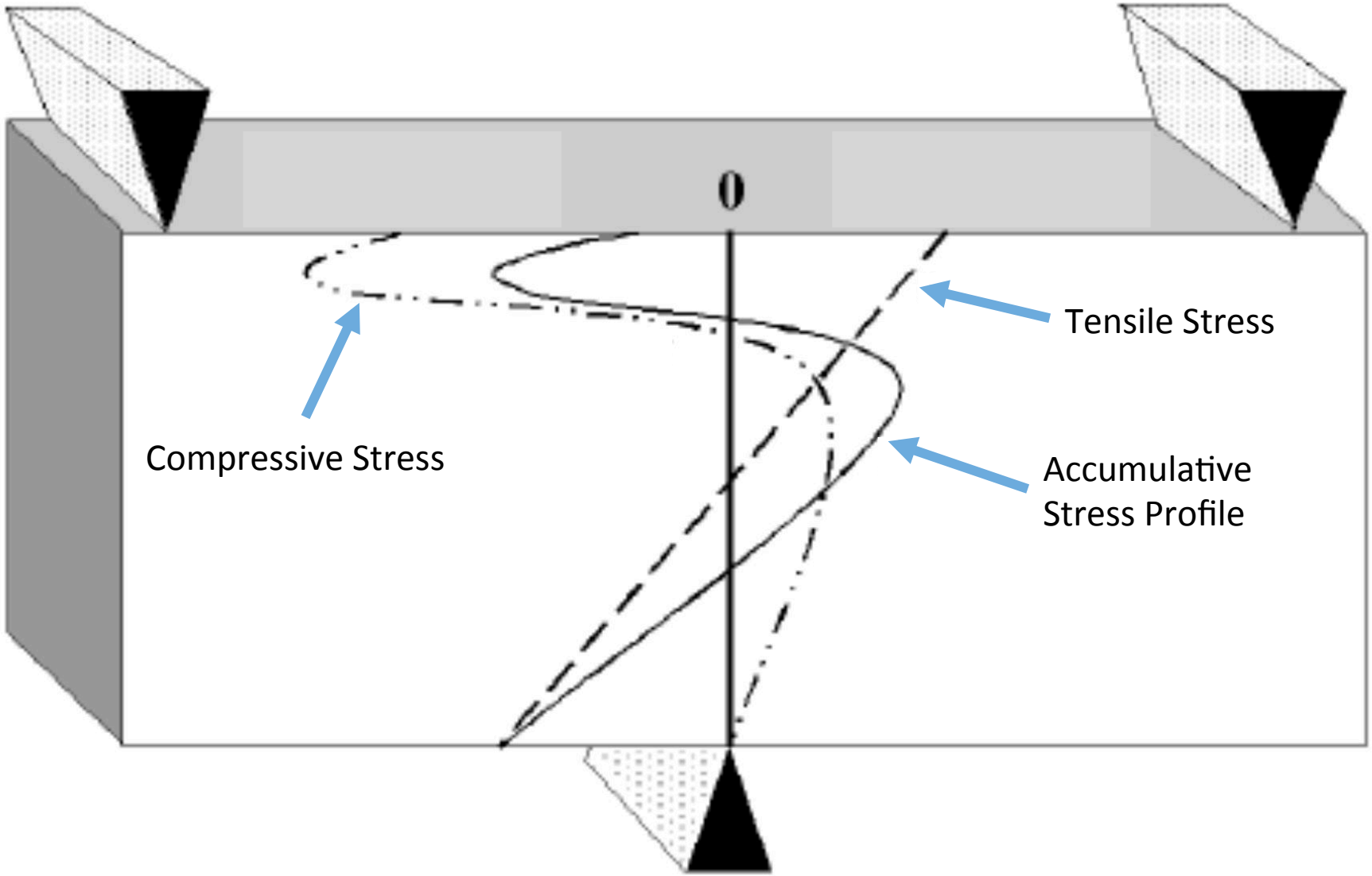


http://www.cwst.co.uk/services/controlled-shot-peening/

Shot Peening Basics



https://uwaterloo.ca/fatigue-stress-analysis-lab/research/residual-stress



Shot Peening Applications. (2005). Espanya: Metal Improvement Company.

Shot Peening Applications

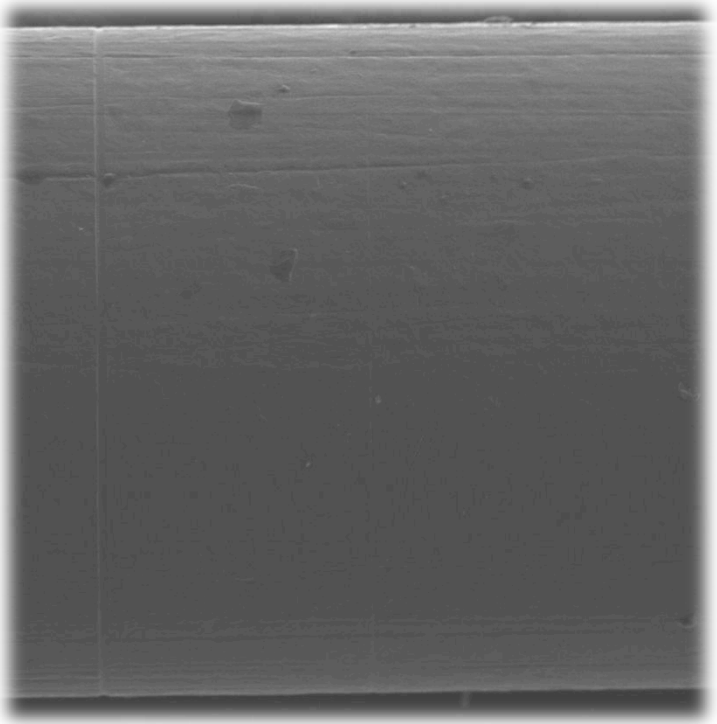
http://dsg.files.app.content.prod.s3.amazonaws.com/
https://qph.ec.quoracdn.net/

The Million Cycle Question…

Can shot peening be used to improve the fatigue properties of Nitinol medical devices without sacrificing biocompatibility?

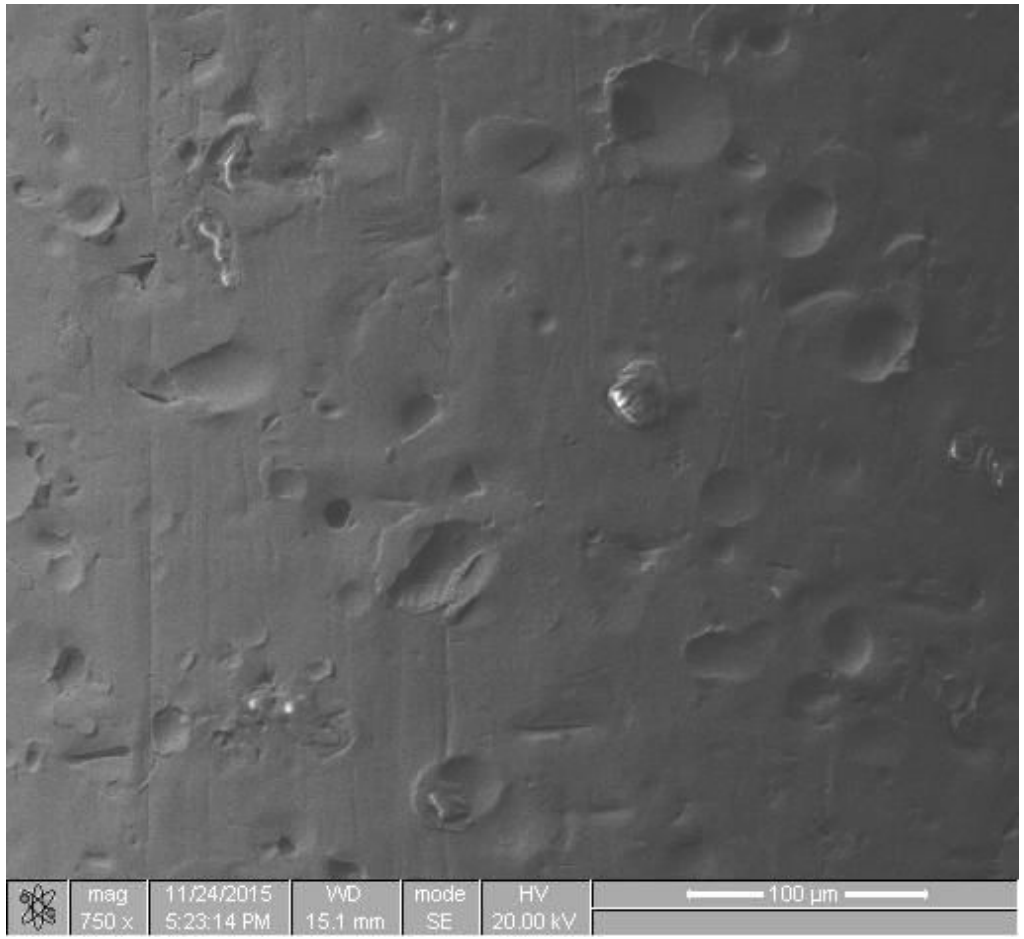
Our Experiment

- Material Tested:
  - SE508 Nitinol wire
  - Diameter: 0.600mm
  - Ground surface
- Peening Media:
  - Biocompatible Ceramic Media
  - Particle Size Range: 150-210µm
  - Shape: Spherical
- Subsequent Surface Processing:
  - Electro Polished then Peened Surface
  - Peened then Electro Polished
    - 0.025mm Material Removal
    - 0.038mm Material Removal
    - 0.051mm Material Removal

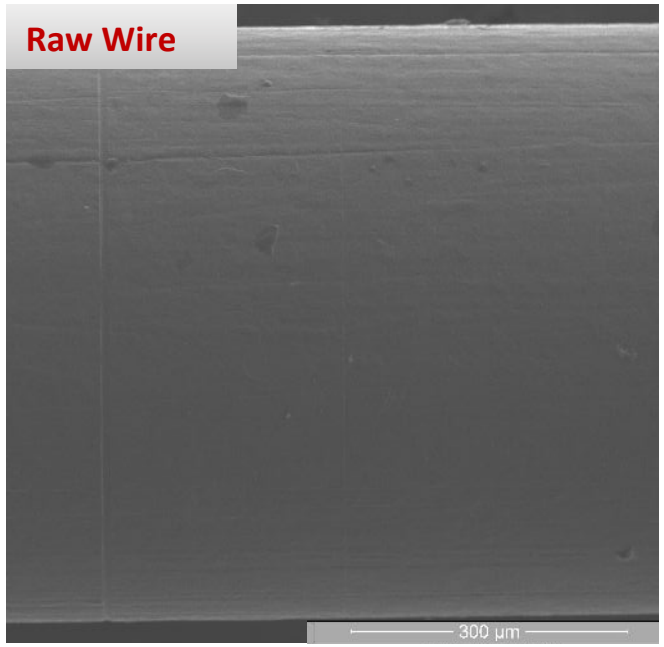


Testing Methods

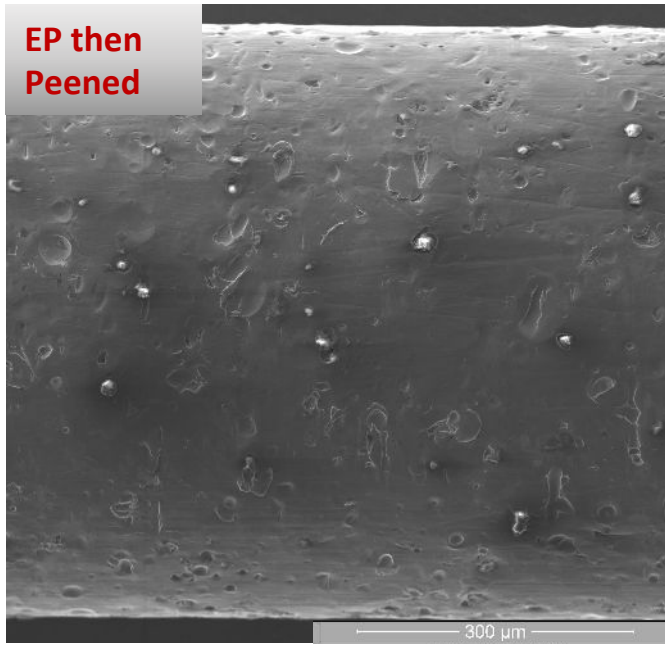
- Rotary Bend Fatigue Testing
  - Strain: 1%
  - Testing Media: Water 37ºC
- Corrosion Testing
  - Per ASTM F-2129
- SEM Imaging of Surface Quality
- EDAX Analysis of Surface Chemistry
- Nickle Ion Release Testing



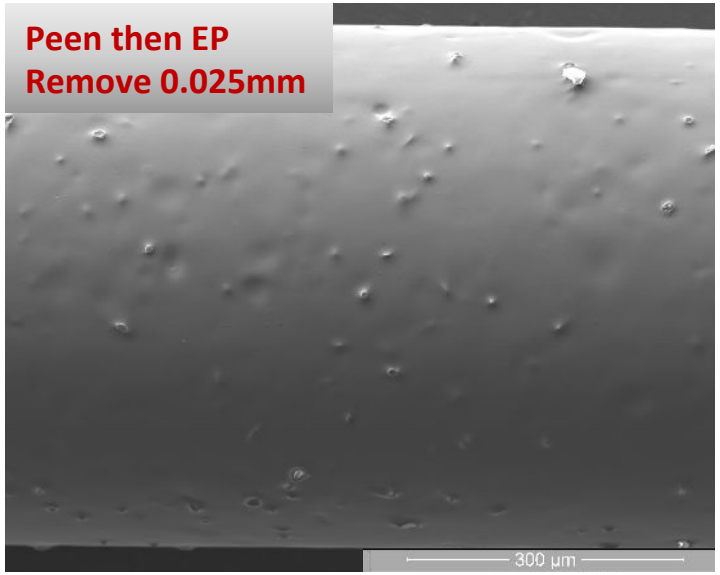
Raw Wire



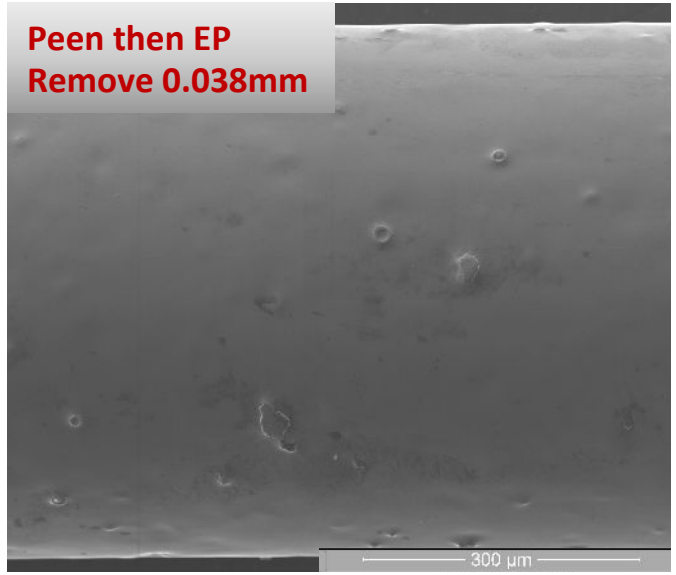
EP then Peened



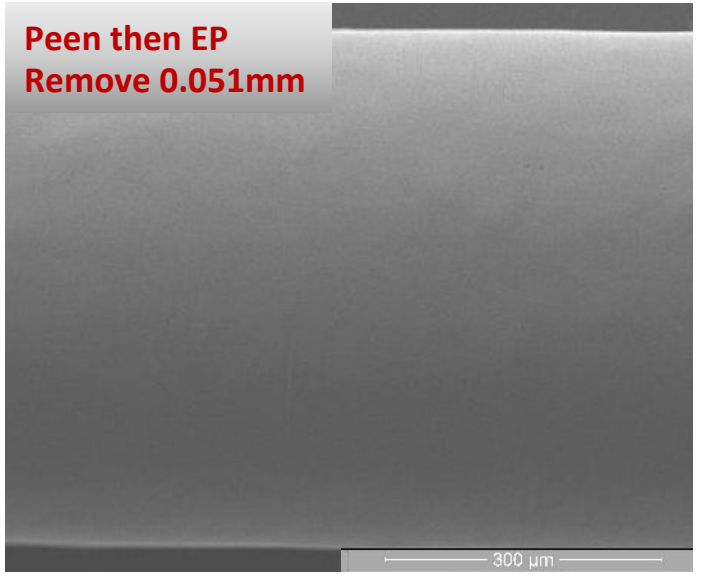
Peen then EP Remove 0.025mm



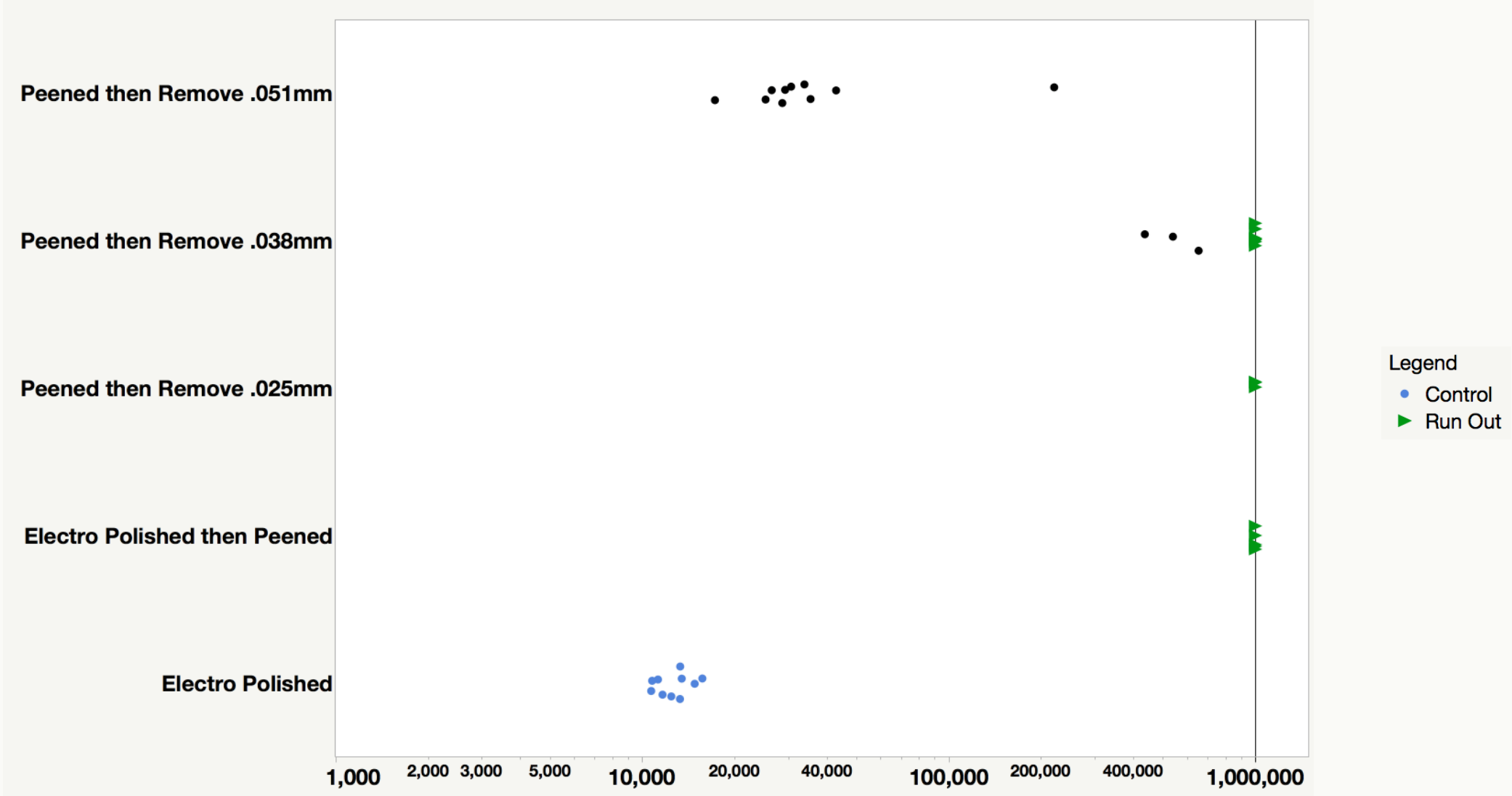
Peen then EP Remove 0.038mm



Peen then EP Remove 0.051mm



Cycles to Break vs. Surface Condition



Corrosion Data

Surface Preparation	Resting Potential (mV)	Break Down Potential (mV)
Electro Polished Wire	84	1050
Electro Polished Wire	87	1050
Electro Polished then Peened	49	353
Electro Polished then Peened	61	246
Peened then EP Remove 0.025mm	5	1090
Peened then EP Remove 0.025mm	24	1090
Peened then EP Remove 0.038mm	63	1070
Peened then EP Remove 0.038mm	84	1060
Peened then EP Remove 0.051mm	74	1060
Peened then EP Remove 0.051mm	80	1050

Corrosion Resistance Key*	
Unacceptable Resistance	<300mV
Marginal Resistance	300-600mV
Optimum Resistance	>600mV

*Per Corbett, R.A. "*Laboratory Corrosion Testing of Medical Implants*" In: Shrivastava S, editor. Proc. Materials and Processes for Medical Devices Conf., Materials Park, OH: ASM International; 2004. p. 166-171.

Conclusions

- Shot peening improves the fatigue performance of Nitinol Wire
- Biocompatibility concerns can be addressed using subsequent processing

Next Steps

- Investigate depth profile of residual stresses
- High cycle fatigue and investigate different strain levels
- Investigation of more complex devices
  - Laser cut stents
  - Thin components

Questions?

bit.ly/smst17ndc

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