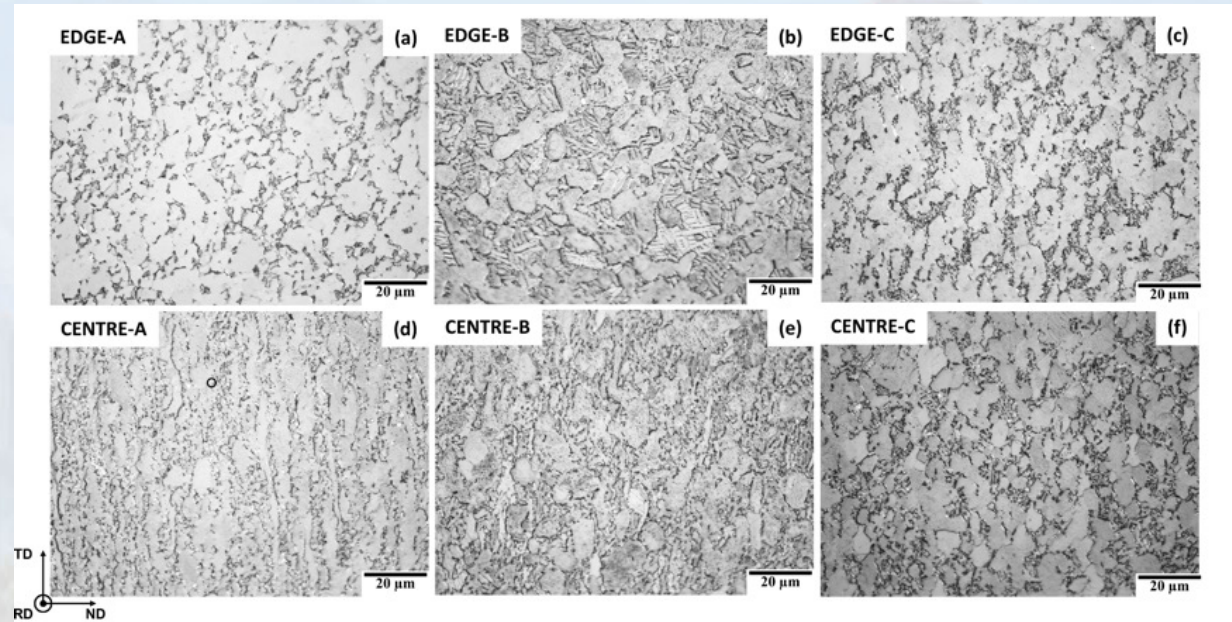
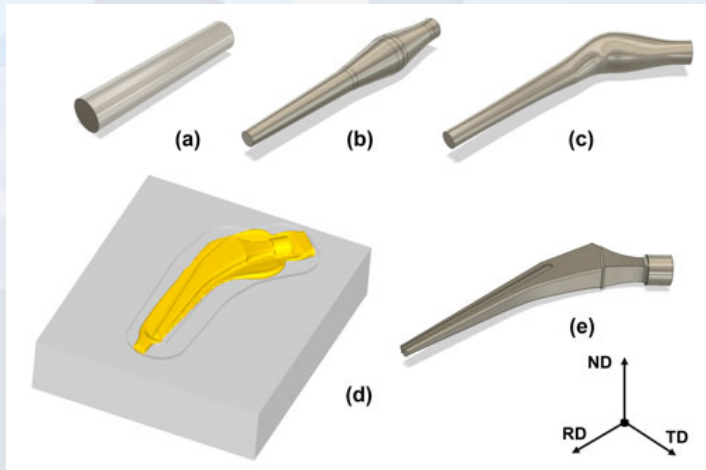


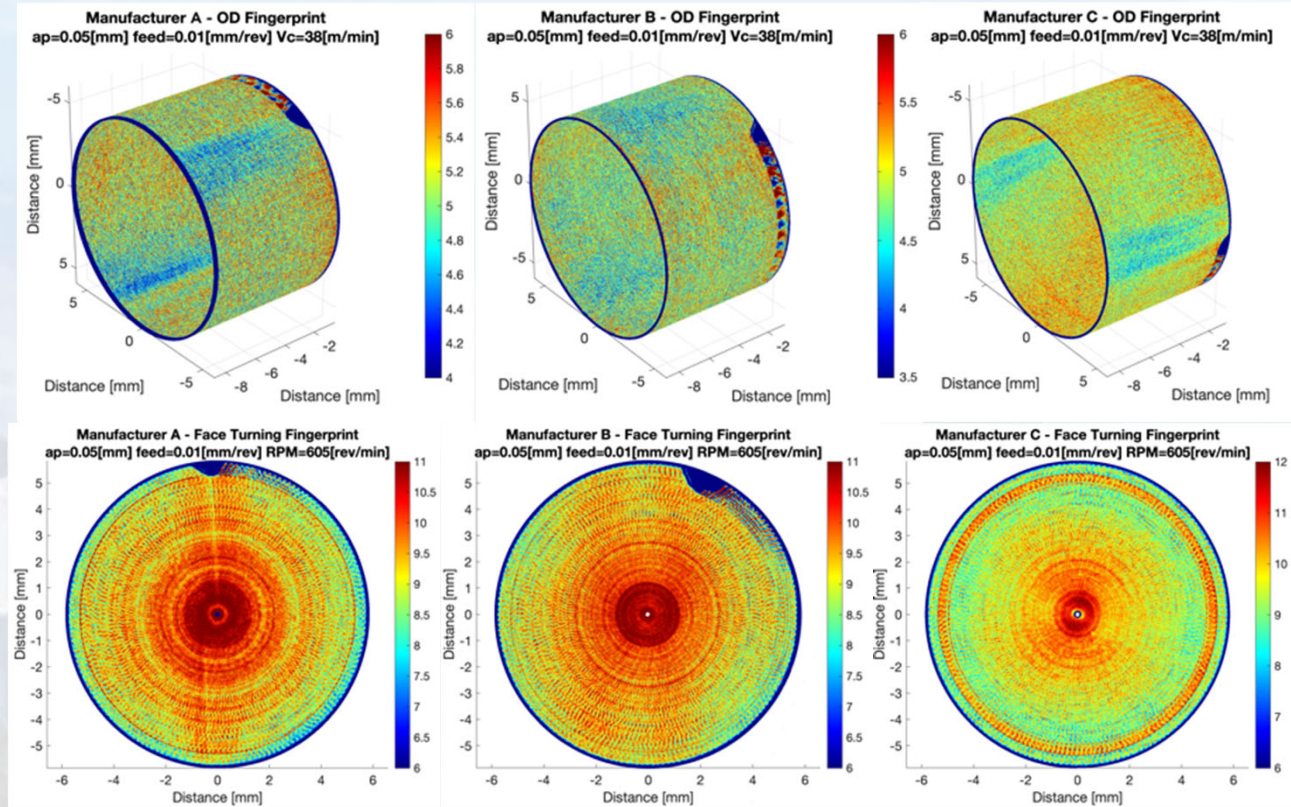
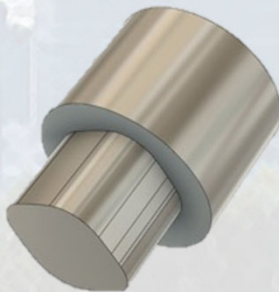
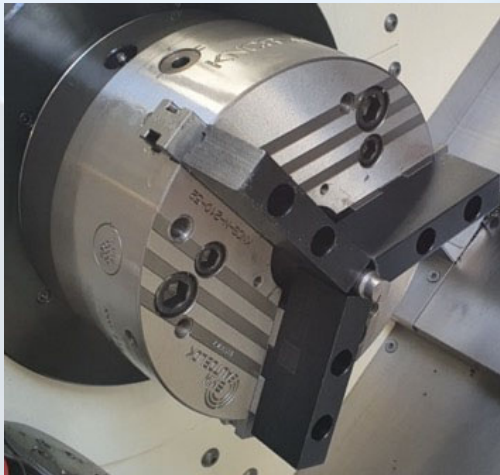
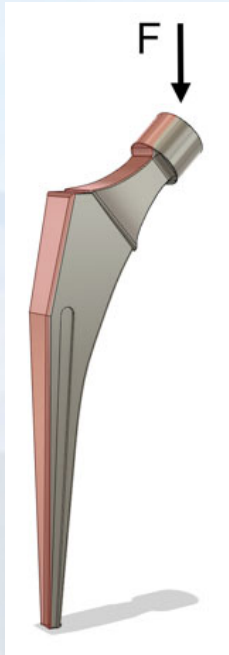
Titanium Hip Joint Analysis

Benchmark providers' quality using standard characterisation techniques and compare with force feedback

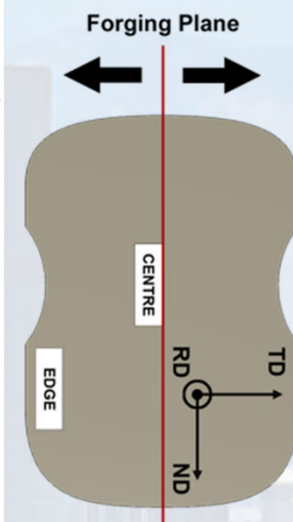
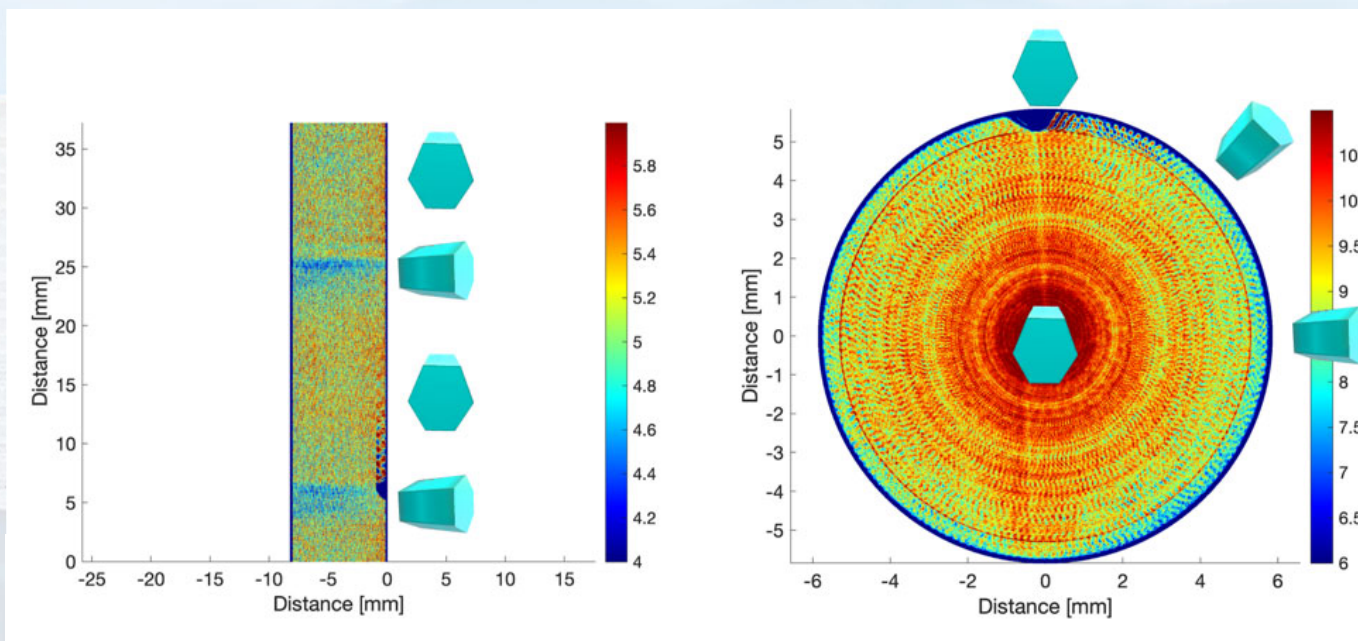
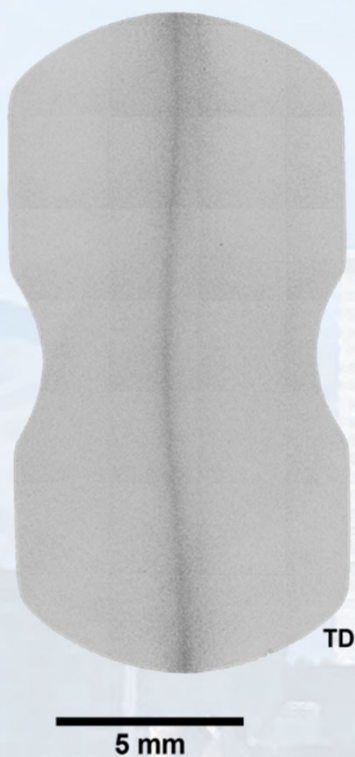
B. Fernández Silva, D. Suárez Fernández, I. Green, and M. Jackson, **Digital Fingerprints of Microstructural Variation in Titanium Alloy Hip Joint Forgings via Machining Force Feedback Analysis Plots**, (2022) Materials Characterisation: A192, 112198.



Titanium Hip Joint Analysis



Titanium Hip Joint Analysis



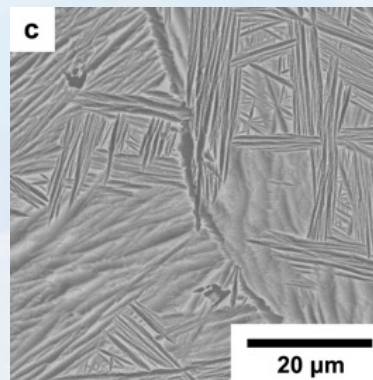
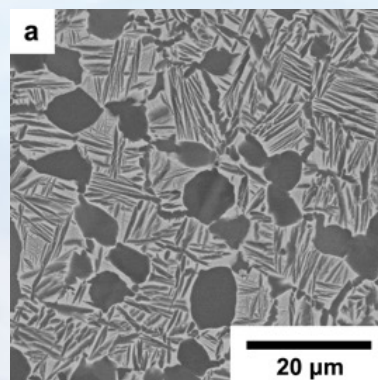
B. Fernández Silva, D. Suárez Fernández, I. Green, and M. Jackson, **Digital Fingerprints of Microstructural Variation in Titanium Alloy Hip Joint Forgings via Machining Force Feedback Analysis Plots**, (2022) Materials Characterisation: A192, 112198.

Martin Jackson, Digital Microstructure Fingerprints from the Machining Force Data

Heat Treatment Identification

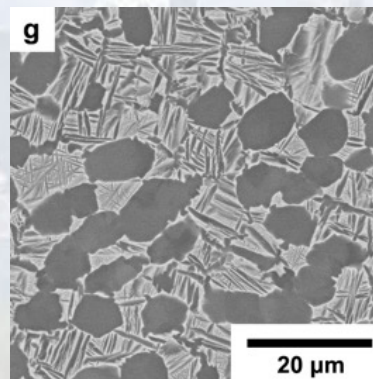
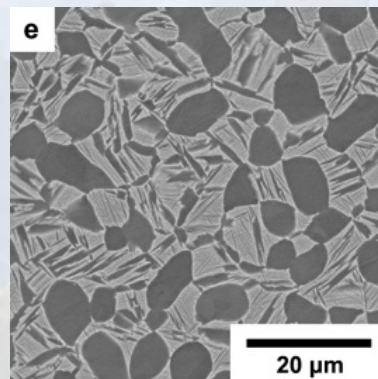
Ti-6246 Example – 4
Different Titanium Billets

As-Forged
Baseline As-Received
Condition



Beta-Annealed
HT: 1000C (1h) + AC

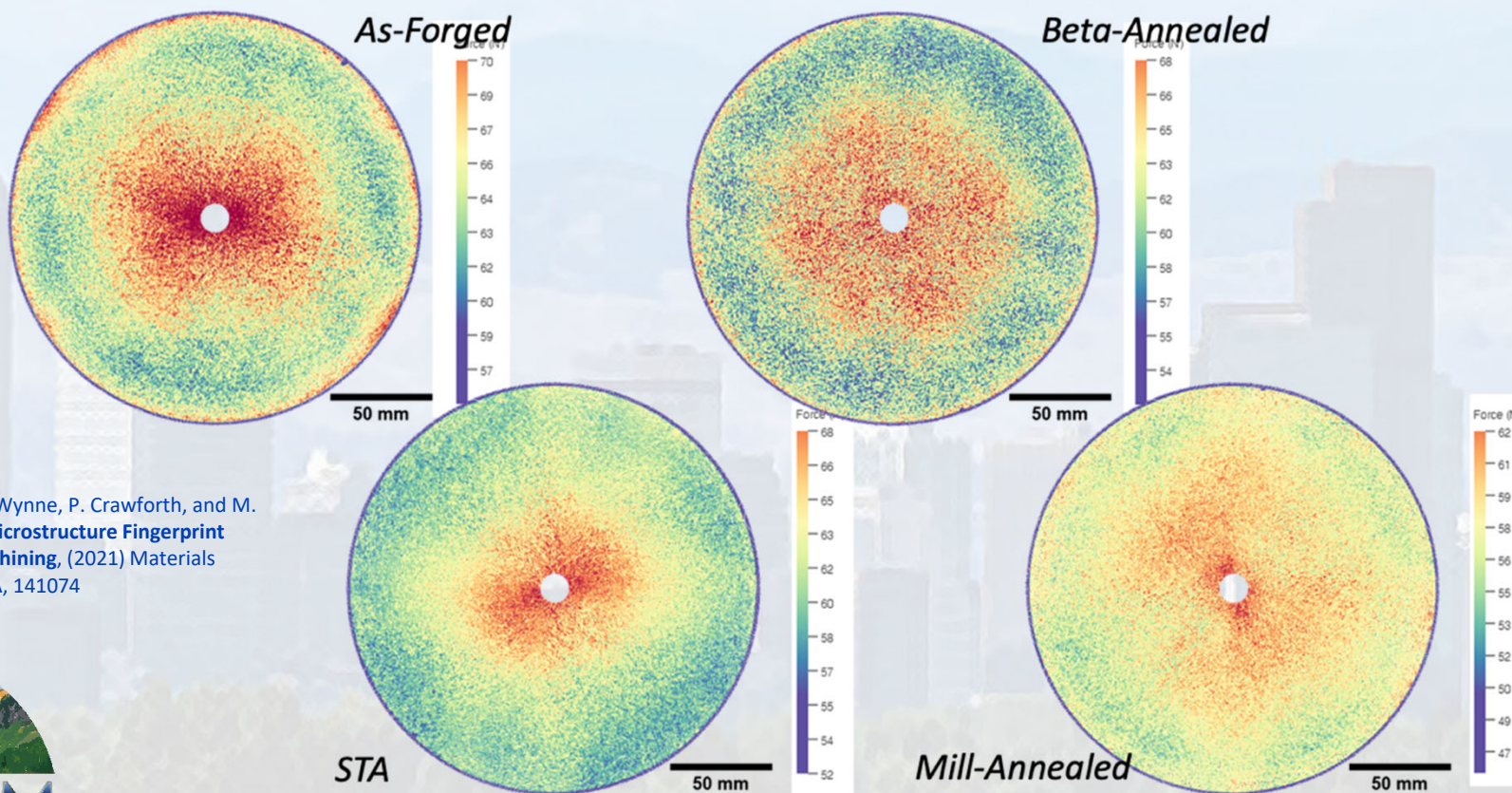
STA
HT1: 900C (1h) + AC
HT2: 677C (8h) + AC



Mill-Annealed
HT: 700C (8h) + AC

D. Suárez Fernández, B.P. Wynne, P. Crawforth, and
M. Jackson, *Titanium Alloy Microstructure
Fingerprint Plots from In-Process Machining*, (2021)
Materials Science and Engineering: A, 141074

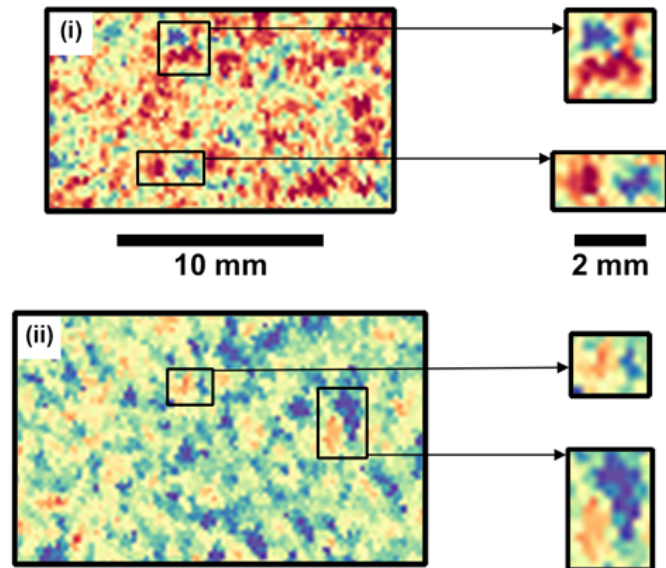
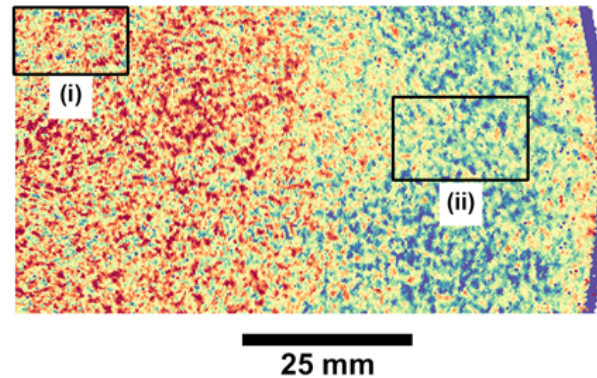
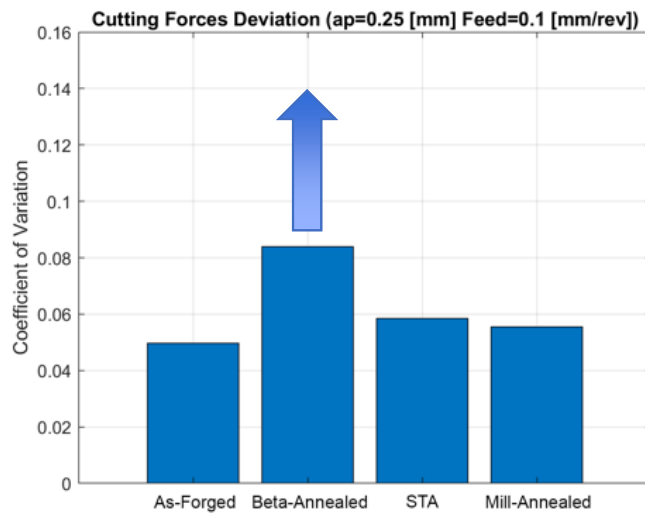
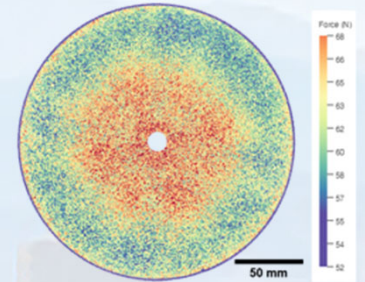
Heat Treatment Identification



D. Suárez Fernández, B.P. Wynne, P. Crawforth, and M. Jackson, **Titanium Alloy Microstructure Fingerprint Plots from In-Process Machining**, (2021) Materials Science and Engineering: A, 141074

Heat Treatment Identification

Supertransus processed material
presents largest force fluctuation



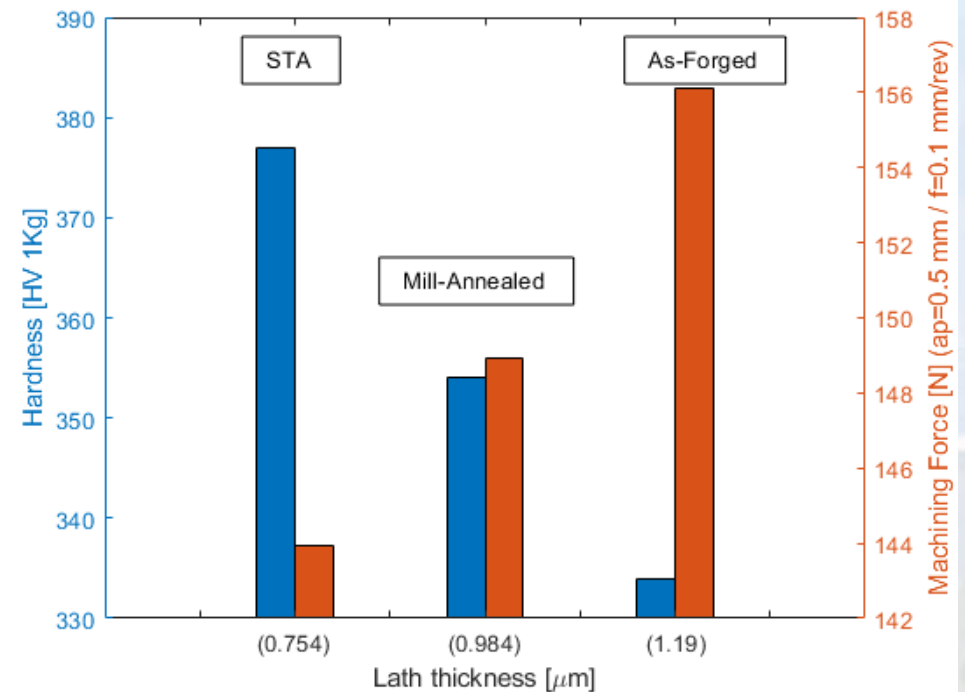
Heat Treatment Identification

Although resolving single laths is currently **beyond** the force feedback **resolution**:

Sub-transus processed **microstructures** presented a clear trend: The Average Machining Force is

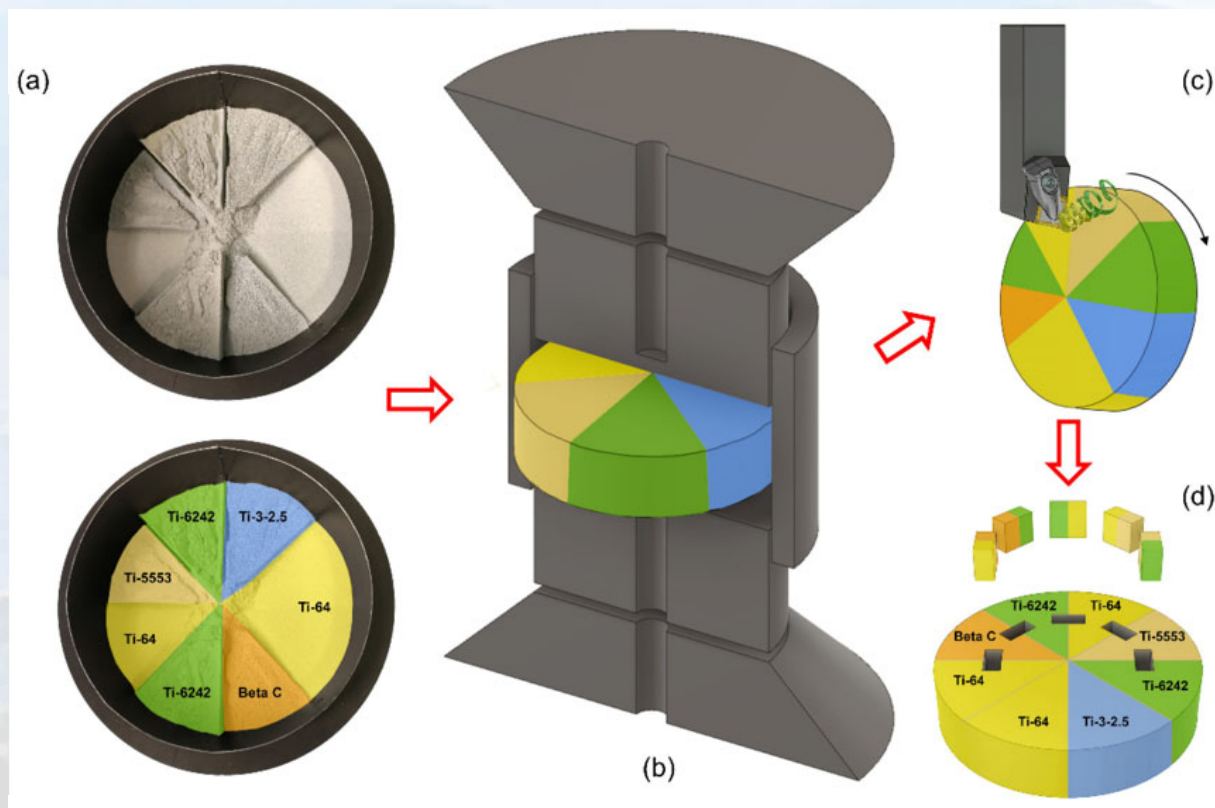
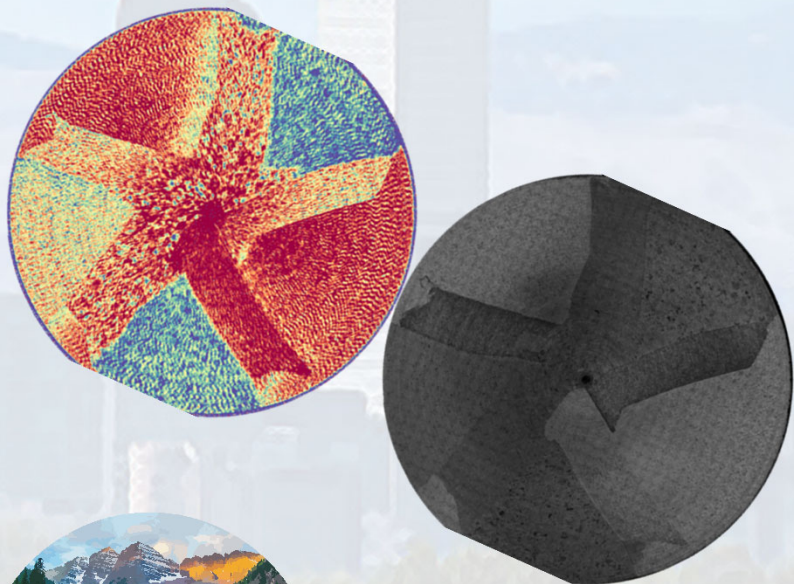
- Directionally proportional to **secondary alpha lath thickness**
- Inversely proportional to **Hardness**

D. Suárez Fernández, B.P. Wynne, P. Crawforth, and M. Jackson, **Titanium Alloy Microstructure Fingerprint Plots from In-Process Machining**, (2021) Materials Science and Engineering: A, 141074



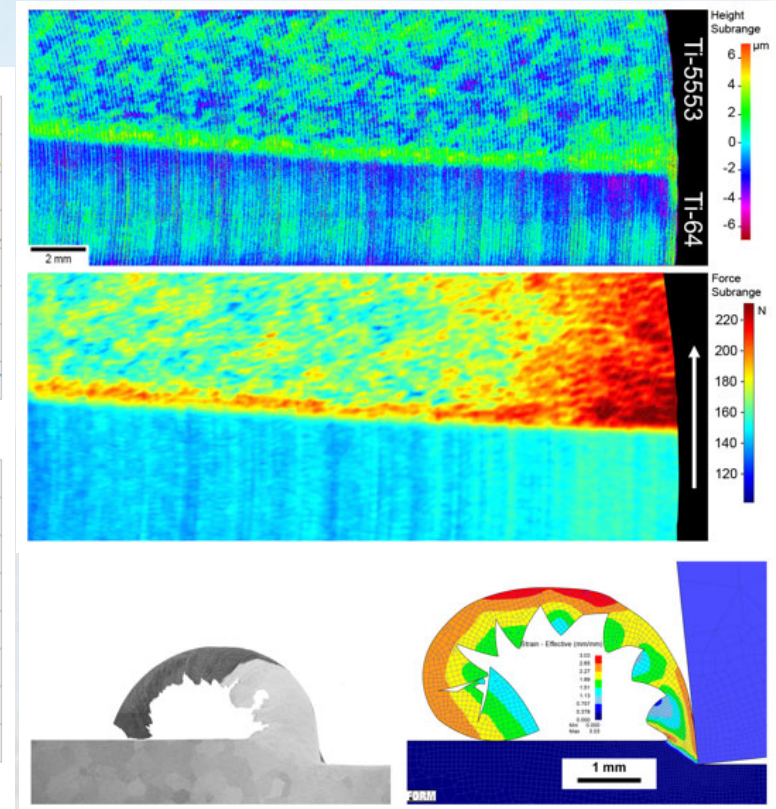
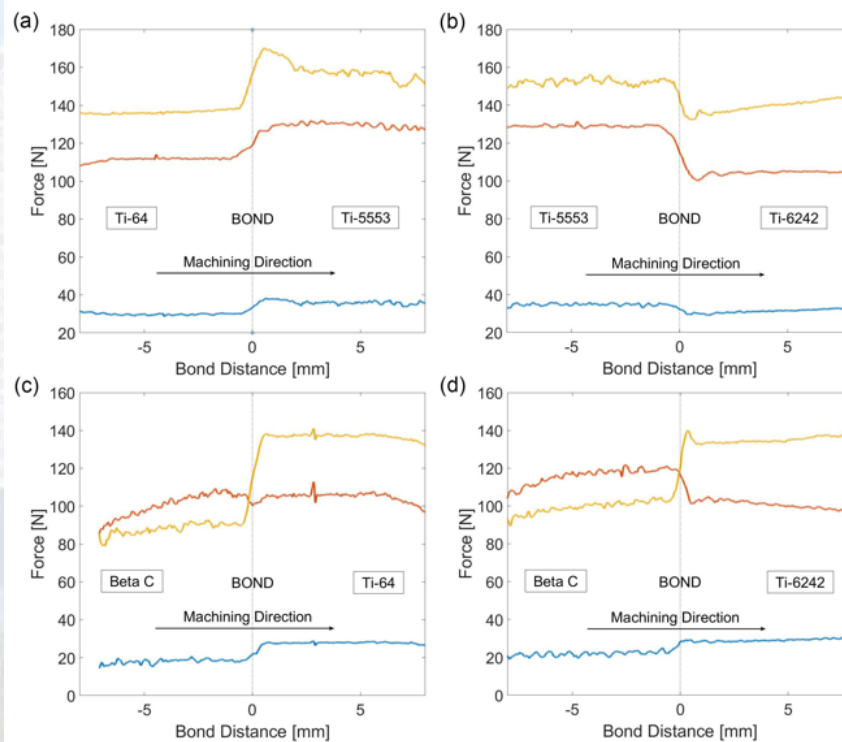
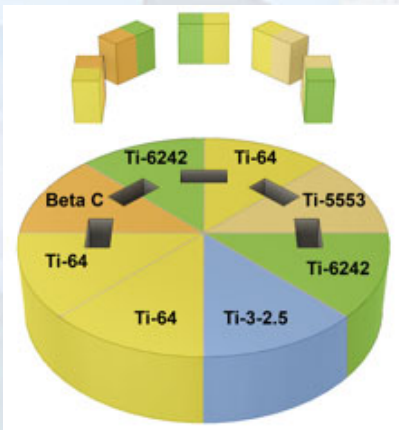
Alloy Chemistry Detection (Turning)

O. Levano Blanch, D. Suárez Fernández, A. Graves, and M. Jackson, *MuTi-FAST: A Machinability Assessment of Functionally Graded Titanium Billets Produced from Multiple Alloy Powders*, (2022) *Materials*, 15:9, 3237



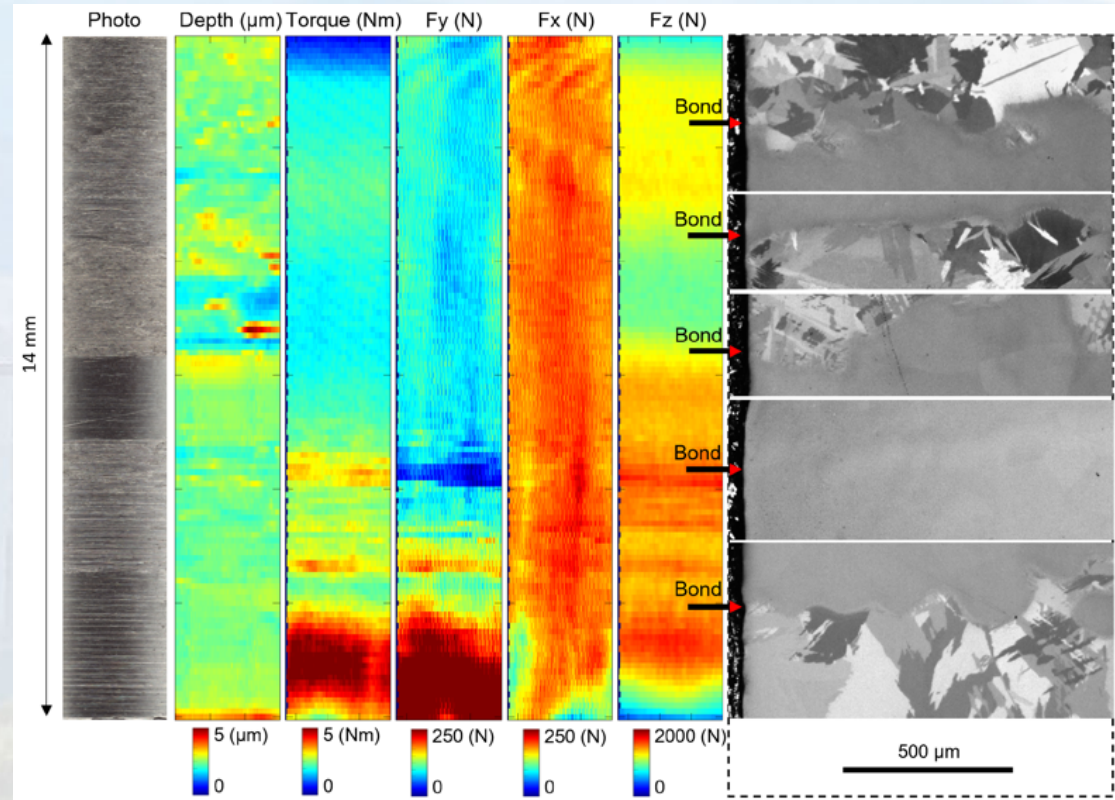
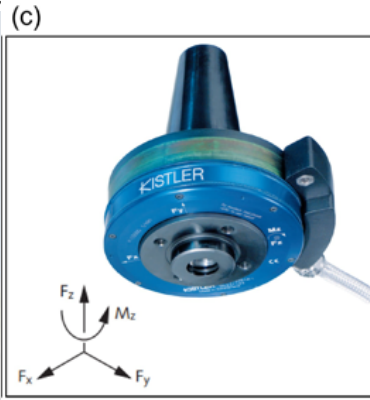
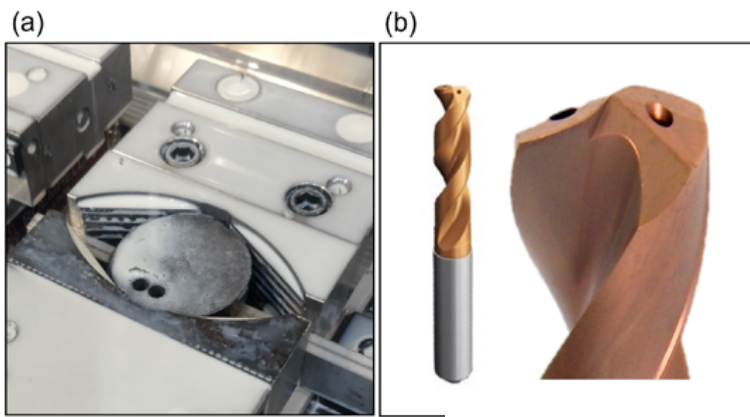
Alloy Chemistry Detection (Turning)

O. Levano Blanch, D. Suárez Fernández, A. Graves, and M. Jackson,
*Mu/Ti-FAST: A Machinability Assessment of Functionally Graded
Titanium Billets Produced from Multiple Alloy Powders*, (2022)
Materials, 15:9, 3237



Martin Jackson, Digital Microstructure Fingerprints from the Machining Force Data

Alloy Chemistry Detection (Drilling)



A. Graves, O. Levano Blanch, D. Suárez Fernández, and M. Jackson, **In-Process Fingerprints of Dissimilar Titanium Alloy Diffusion Bonded Layers from Hole Drilling Force Data**, (2022) Metals, 12 (8), 1353.

Summary

Force feedback approach can detect changes in:

- grain structure/texture
- alloy chemistry
- substructure (HT condition)
- create digital fingerprints

