Laser alloying of *Al* with *Ti* and *Ni* based powders to improve wear resistance and hardness

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Presentation Outline

- Introduction
- Experimental Method
- Results
- Conclusions

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Introduction

- Aluminium is extensively used in industry
  - Low cost
  - Light weight
  - Excellent workability
- But has poor wear resistance and low hardness

Objective

- To improve the surface hardness and wear resistance of Al AA1200 by laser alloying with mixed Ni and Ti powders

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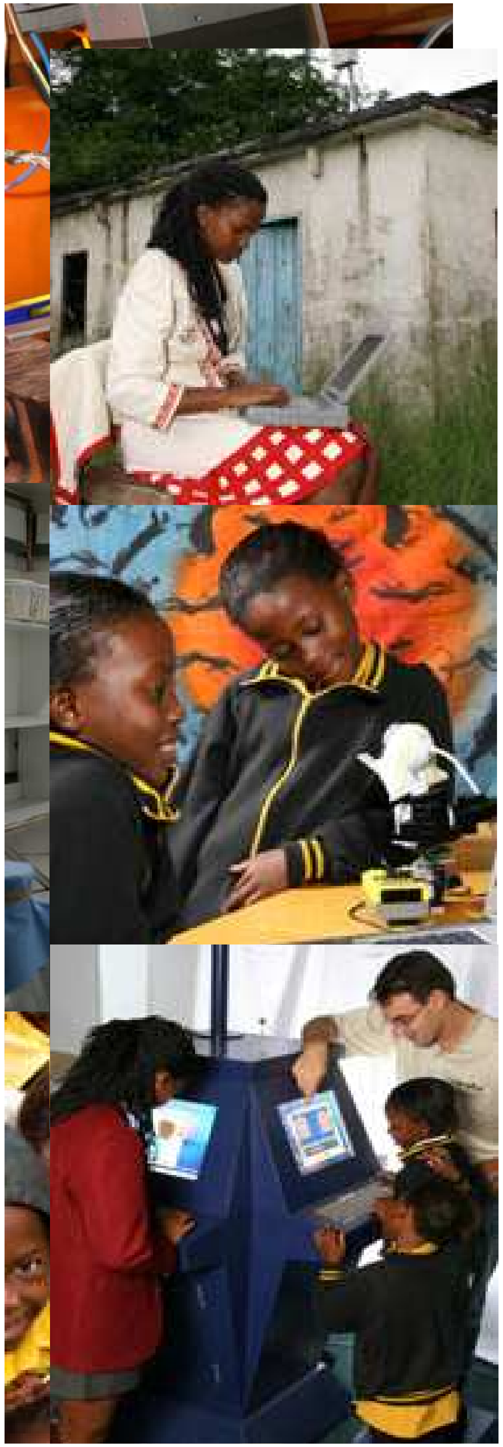

Laser alloying technique

- Improve the surface properties by modifying the composition and microstructure without affecting the bulk properties of the material
- Involves melting the substrate surface and blowing the powder of the alloying material into the melt pool
- ➢ Fast and accurate
- ➢ Many materials can be alloyed into different substrates

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Experimental Method

A

B

Figure 1:(A) Nd:YAG laser
(B) Experimental setup

- Laser alloying was carried out with a 4.4 kW Rofin Sinar Nd:YAG laser
- Beam focus diameter of 4mm on the substrate
- Argon shielding gas
- The flow rate of the shielding gas was set at 2L/min

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Experimental Method

- Aluminium AA 1200 base material
- Ti and Ni powder mixtures
- Powder particle size was between 40 and 100µm
- Different laser scanning speeds (0.01m/s, 0.012m/s, 0.015m/s and 0.020m/s) used
- Single and multiple laser alloyed tracks were created on the surface
- For multiple laser alloyed surface an overlap of 15% between adjacent tracks was used

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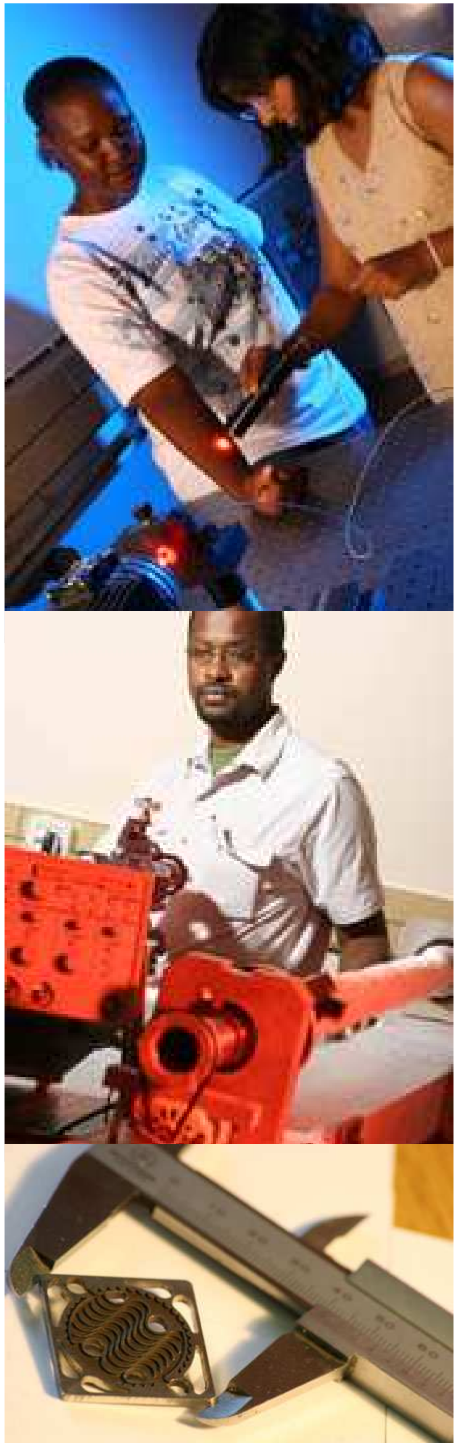
Hardness

- Polished cross-sections
- The through-thickness hardness measurements
- Load used 100g
- Indentation spacings was 100µm



Wear tests

- The tests were performed on laser alloyed surfaces composed of multiple passes
- The abrasive used was silica sand
- Test specimens were 20mm x 20mm x 5mm in size
- The load used was 10kg force

Results

- A homogeneous microstructure was obtained at 0.010m/s and 0.012m/s scanning speeds
- The was no sufficient melting and infusion of the powder into the substrate obtained at high laser scanning speed
- The thickness of the alloyed layer was ~0.52mm

10wt% Ti and 90wt% Ni at 0.010m/s

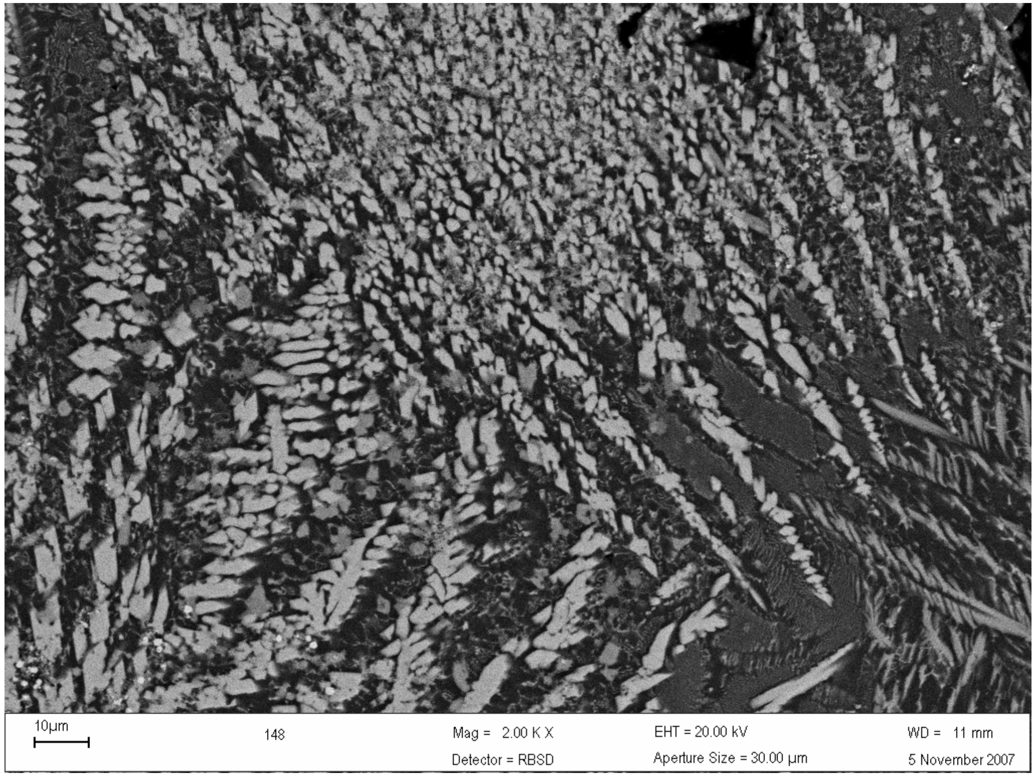


Figure 2: SEM micrograph of the surface alloyed with 10wt% Ti and 90wt% Ni at 0.010m/s

XRD Pattern

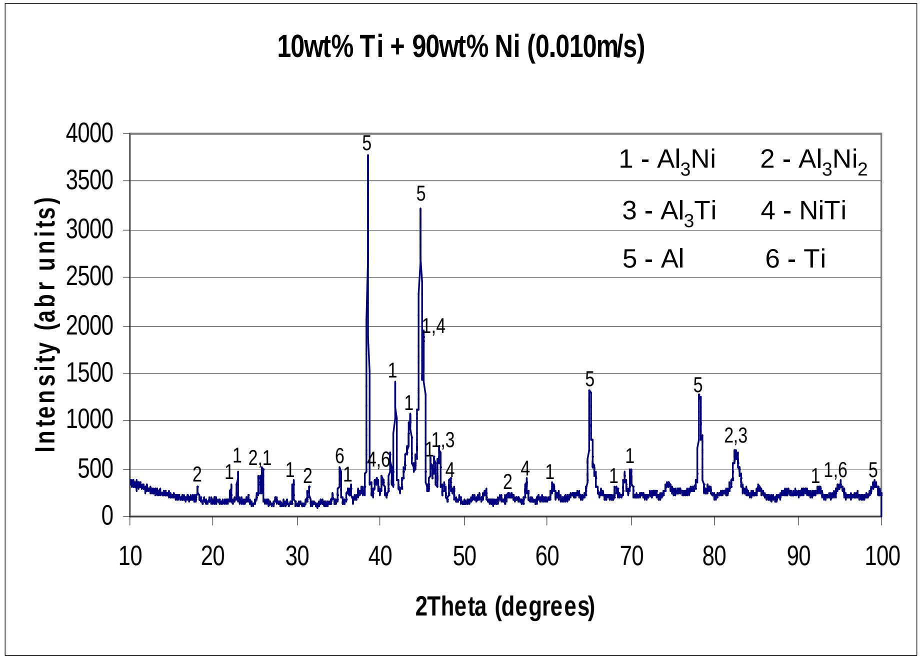


Figure 3: XRD pattern of the surface alloyed with 10wt% Ti and 90wt% Ni at 0.010m/s

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70wt% Ti and 30wt% Ni at 0.010m/s

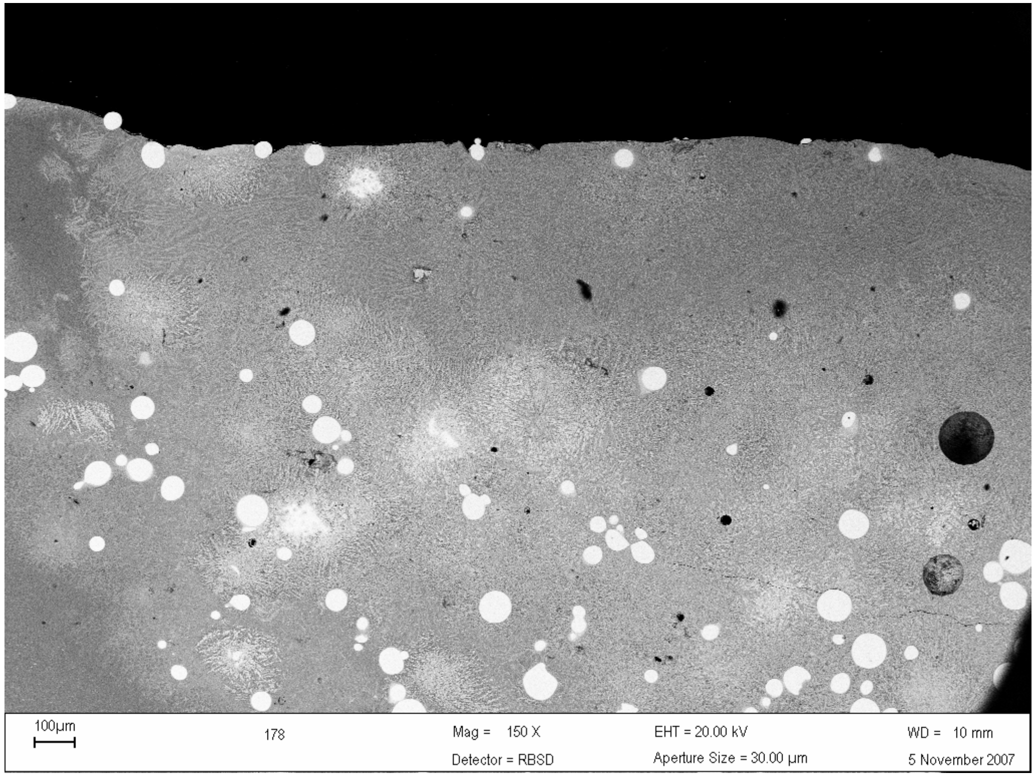

Figure 4: SEM micrograph of the surface alloyed with 70wt% Ti and 30wt% Ni at 0.010m/s

XRD Pattern

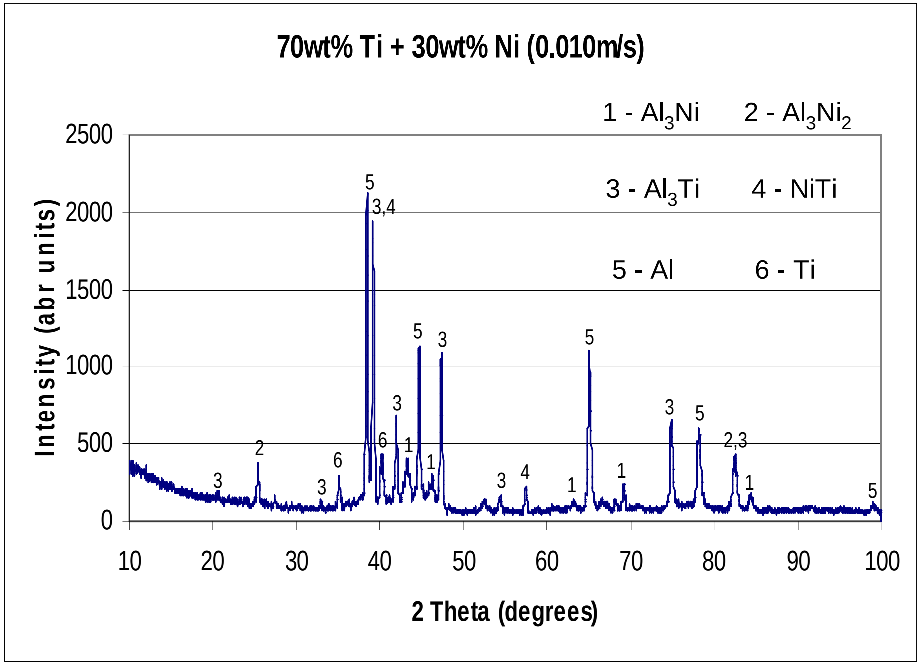

Figure 5: XRD pattern of the surface alloyed with 70wt% Ti and 30wt% Ni at 0.010m/s

Hardness Results

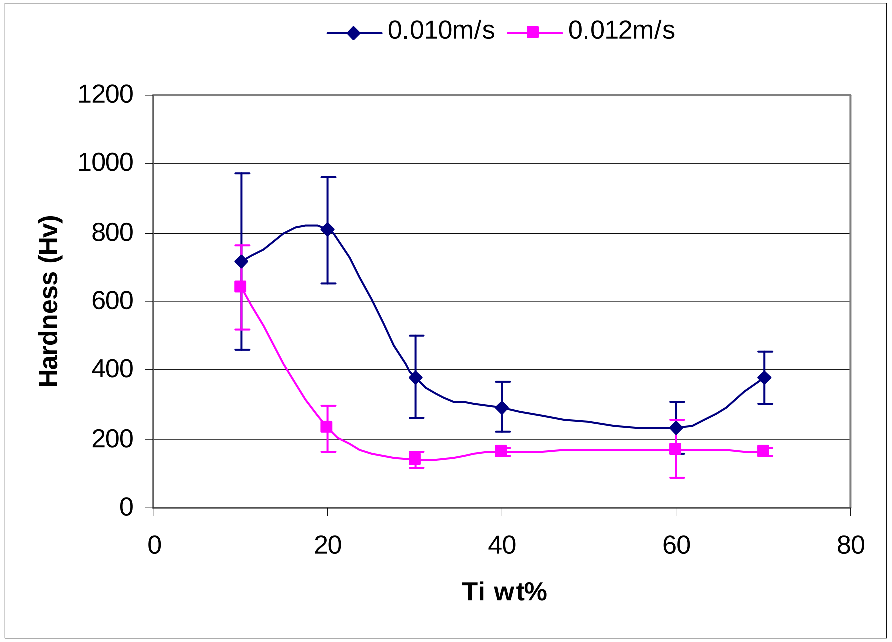

Figure 6: Hardness versus Ti wt%

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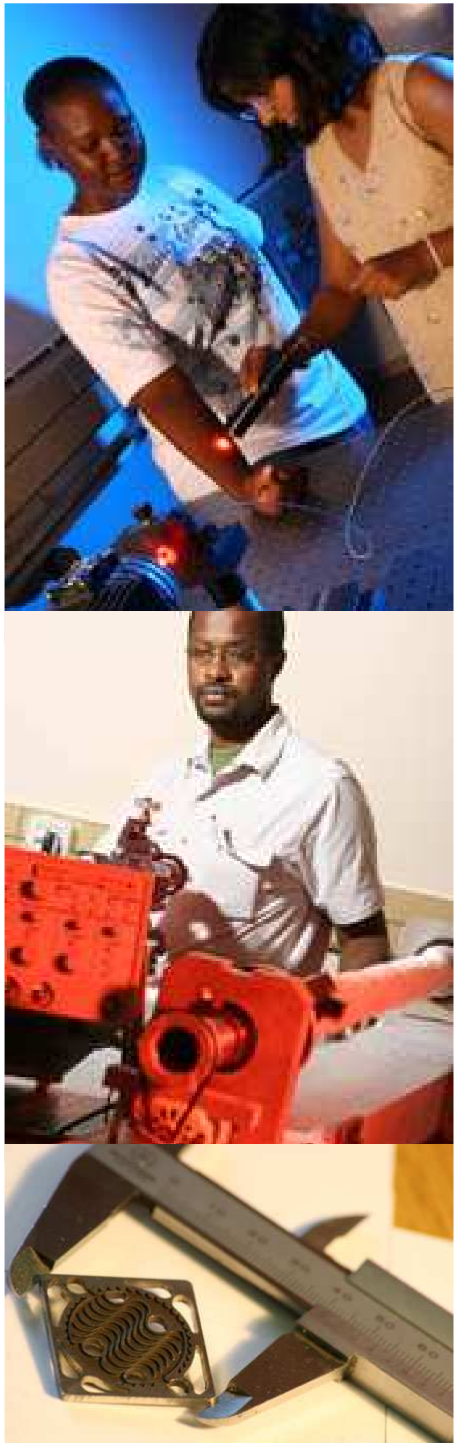

Wear Result

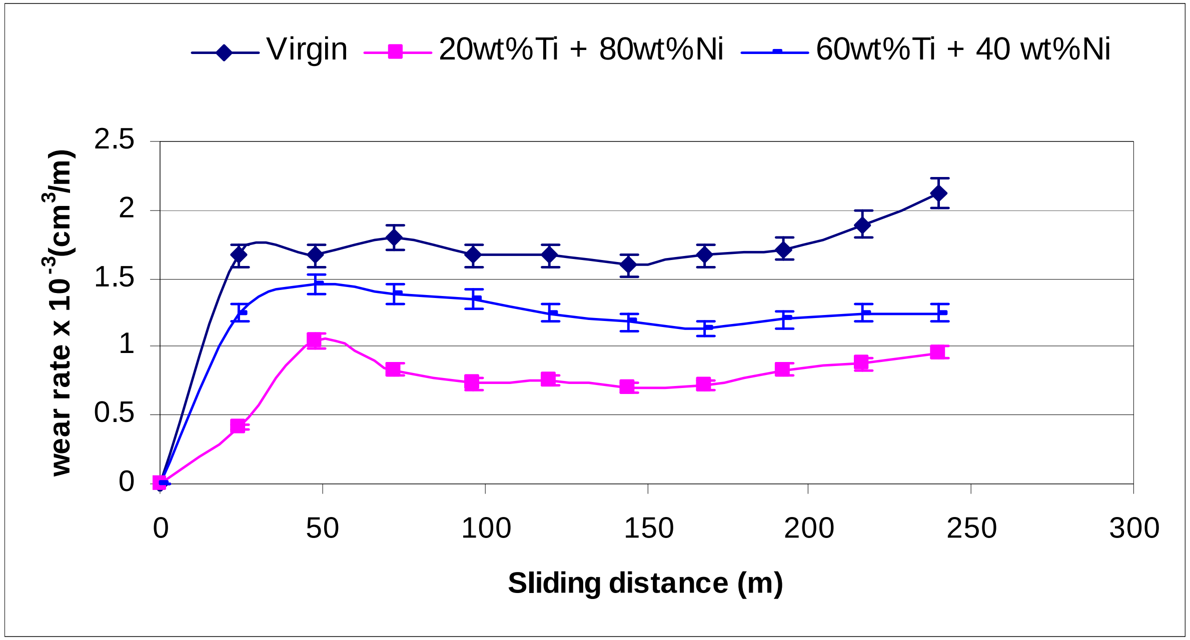

Figure 7: Wear rate versus sliding distance

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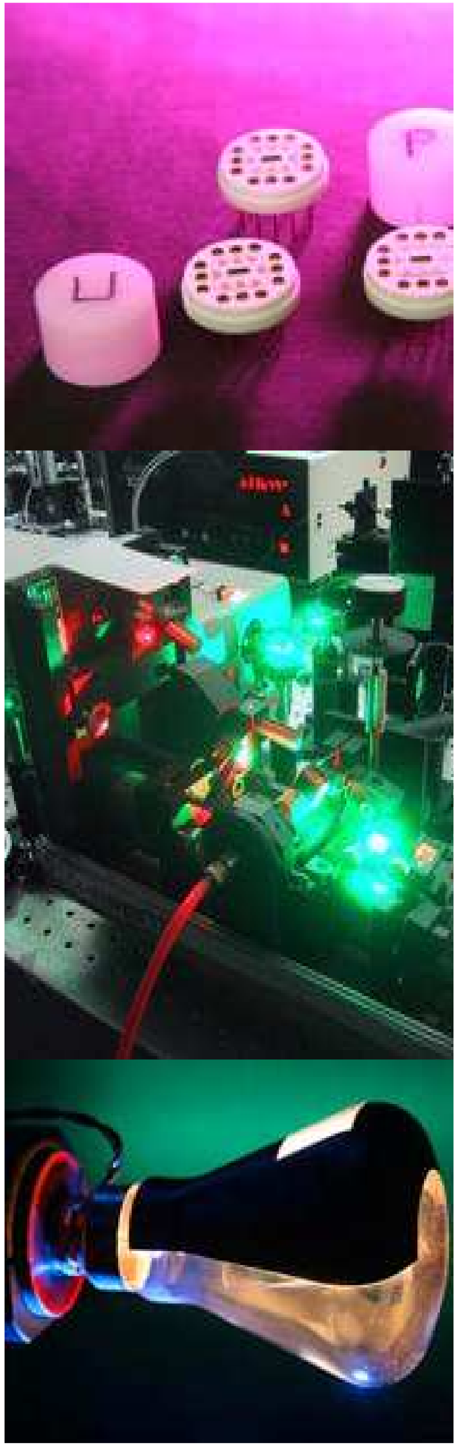

Worn Surfaces

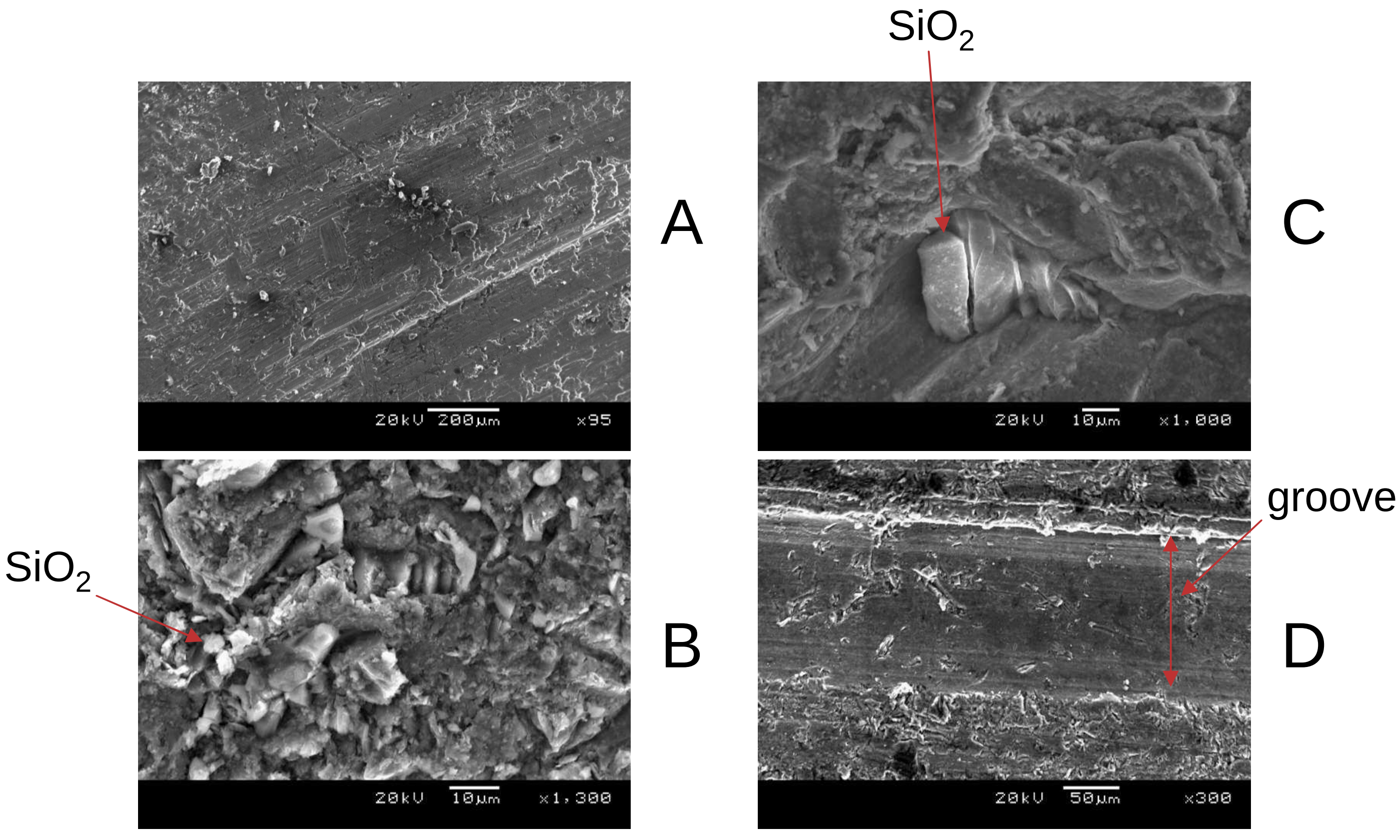

Figure 8: Worn surfaces of Al (A), alloyed with 10wt%Ti and 90wt%Ni (B & C) and alloyed with 20wt%Ti and 80wt%Ni (D)

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Conclusions

- Improved hardness and wear resistance was achieved after laser alloying at 0.010m/s and 0.012m/s laser scanning speeds
- The hardness of the laser alloyed surfaces decreased as the Ti content in the Ni/Ti powder mixture increased
- The wear resistance decreased as the Ti content increased
- Grooves, cracks and microfracturing were the dominant wear features for the laser alloyed Al alloys.

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Thank you

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