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# Effect of ruthenium additions on the corrosion and mechanical properties of the weld metal of 316L austenitic and LDX 2101 duplex stainless steels

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**Abstract**

Austenitic stainless steels (ASSs) and duplex stainless steels (DSSs) are widely used in high performance pressure vessels, nuclear, chemical, process and medical industry due to their very good corrosion resistance and superior mechanical properties. Welding is a common technique used to join 316L ASS or LDX 2101. 316L is a molybdenum bearing ASS, while LDX 2101 is a duplex stainless steel that was patented by Outokumpu in 2013. This work validated the potential benefit that Ru additions would have on the corrosion resistance of the weld metal based on microstructural and mechanical properties. The microstructures of all 316L gas tungsten arc welding (GTAW) button samples in Figure 1 exhibited γ-austenite phases with δ-ferrite at the dendritic boundaries.

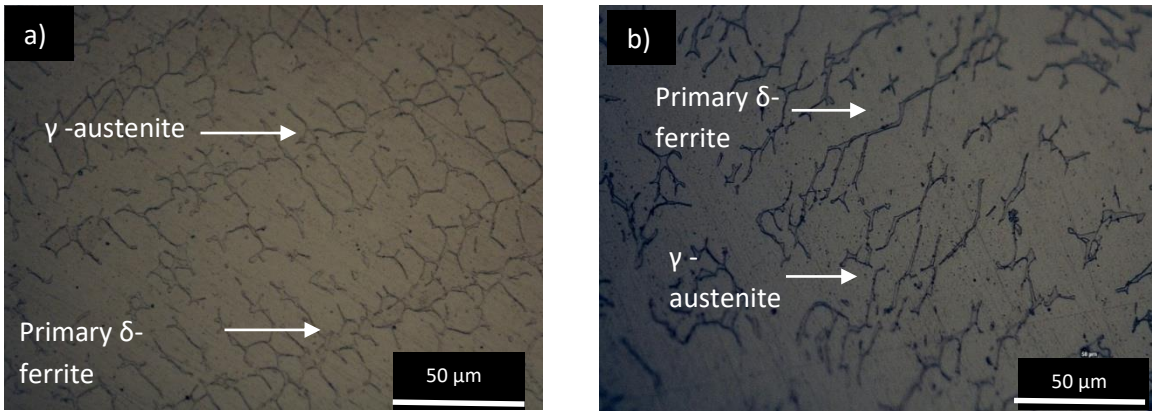



**Figure 1: (a) 0.1 wt% Ru (b) 2 wt% Ru to 316L ASS after GTAW.**

Bulky δ-ferrite phases extending to thin dendrite arms were observed at 0.1 wt% Ru (Figure 1 a) while a skeletal δ-ferrite microstructure (Figure 1 b) was observed with 2 wt% Ru addition.

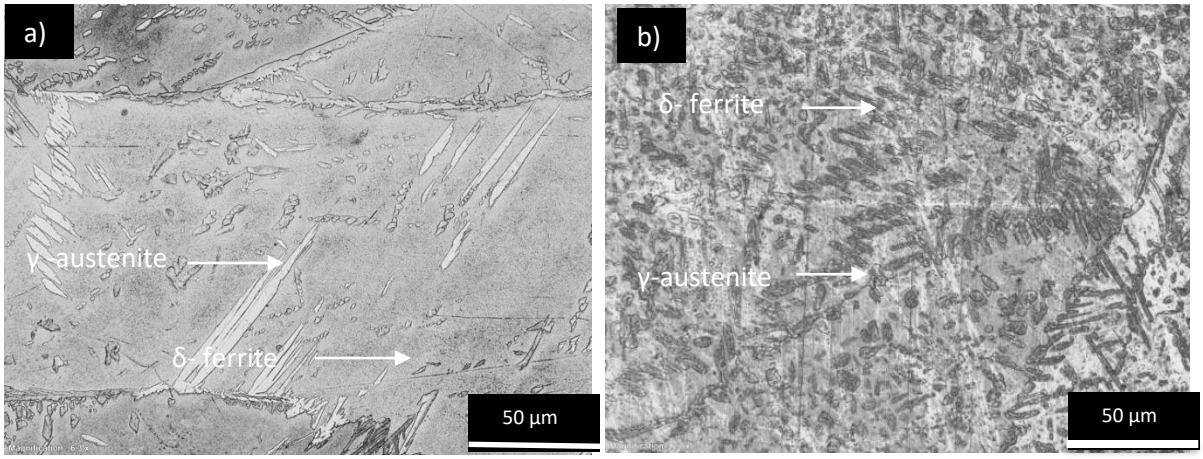



**Figure 2: (a) 0.1 wt% Ru (b) 2 wt% Ru to LDX 2101 ASS after GTAW.**

The ferrite-austenite (FA) solidification mode suggested that an incomplete solid-state transformation had occurred due to the melting of the 316L in water cooled conical shaped copper mould. The hardness results revealed that 316L ASS (Figure 1) and LDX 2101 (Figure 2) had an increase in hardness as Ru additions were increased due to grain refining nature of Ru. The potentiodynamic polaristion test indicated that as Ru addition increased there was an increase in corrosion resistance for both 316L and LDX 2101. Overall, it was concluded that the addition of Ru exhibits no detrimental effect of the solid state transformation but rather strengthens the alloy as Ru increases. Ruthenium additions in the stainless steels not only improves the weld metal mechanical properties but can improve the corrosion resistance of the weld metal.

Keywords—*austenitic, corrosion, duplex, ruthenium.*

**Professional Biography (100-150 words)**

Mrs Bridget Zuma has completed her undergraduate degree from University of Pretoria. She has further completed her Master's degree at University of Witwatersrand. She is the Metals division, Alloy and Blending specialist at Hulamin Operation and Director at RUZ Group. She has published numerous papers in reputed journals, and conference proceeding and represented South Africa at International Conferences in Europe. She has represented Johannesburg at the IOM3 nationals taking 3rd place country wide. At the university of Witwatersrand Metallurgy department, she was honoured with second prize best postgraduate projects. She has won first place at the SIAMM 2015 annual colloquiums.



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**Any Comments:**