

COLLABORATIVE RESEARCH SAVES THE DAY FOR LOCAL HEAVY INDUSTRY

The capital-intensive steelmaking, power generation and oil and gas sectors of South Africa's economy have a common challenge – that of remaining competitive in the global market using existing and often ageing production plant.

Industry's collaboration with the physical metallurgy research group of the Department of Materials Science and Metallurgical Engineering at the University of Pretoria demonstrates breakthroughs where innovative research has facilitated advances in the local heavy industry to stave off global competition.

The South African stainless and carbon alloy steel industries are facing fierce commercial competition from the Far East. One such example is where high-strength microalloyed plate steels that combine the alloying elements titanium and niobium are produced with modern equipment, for export to the entire global market. These steels cannot be successfully produced at the ArcelorMittal South Africa (AMSA) plate mill in Vanderbijlpark, due to the high hot rolling forces, and the difficulty in shape control associated with steel.

Plate mill operator about to measure the thickness of the red-hot plate rolled from an input slab.



ArcelorMittal South Africa

AMSA, through its research collaboration with the Physical Metallurgy Research group at UP, has countered this threat by using a locally abundant alloying element, vanadium, in conjunction with nitrogen. Key to this development was the research that uses precipitation strengthening during transformation of the steel microstructure. Further, by using vanadium (instead of titanium and niobium), and by following hot rolling strategies developed at UP, high roll forces and poor shape could be avoided. The studies modelled the extent of recrystallisation during hot rolling and the impact of recrystallisation on flow stress at elevated temperature.

The work has been published in prominent journals and several postgraduate degrees have been awarded. In 2016, the research leader of the Industrial Metals and Minerals Research Institute (IMMRI), Dr Kevin Banks, presented further proposals to Vanitec, a global vanadium organisation, and a three-year research contract was awarded, a first for South Africa.

In the oil and gas sector, collaborative research work, led by Professor Pieter Pistorius, was awarded with



Front left: Waldo Stumpf, Roelf Mostert, Rorisang Maubane. Back left: Muthiswa Neishilema, Kevin Banks, Alison Tuling, Charles Siyasiya, Vinod Kurup, Kofi Aman, Carel Goetzee, Lies Schoeman, Njingalwazi Magwenzhu, Sibusiso Mahlala. Inset: Pieter Pistorius. Below: Optical micrograph of simulated carbon steel, taken by MSc student, K Lekganyane.

the 2016 SANW Harvey Shacklock Gold Medal Award for a paper presented in Melbourne, Australia in 2016. He has focused on the in-service degradation of welded components due to a relatively rare degradation mechanism, that of graphitisation. In steels operating at elevated temperatures and high pressures, strength is often imparted by iron carbides present at the nano-level. The research involved the characterisation of the service exposed components, the development of welding procedures, and the characterisation of the likely in-service behaviour after repair welding of oil refinery equipment.

