Journal Comment

This special edition of the Journal of the Southern African Institute of Mining and Metallurgy is dedicated to the Nuclear Materials Development Network (NMDN) of the Advanced Metals Initiative (AMI) of South Africa's Department of Science and Technology (DST). The AMI consists of four networks: the Light Metals Development Network (LMDN) which is coordinated by the CSIR, the Precious Metals Development Network (PMDN) and the Ferrous Metals Development Network, both coordinated by Mintek, and the NMDN which is coordinated by the South African Nuclear Energy Corporation SOC Ltd (Necsa). The NMDN focuses on the development and improvement of nuclear materials in order to enhance the safety of nuclear reactors, the characterization of nuclear materials by various analytical techniques including nuclear techniques, and the beneficiation of South African minerals across the whole value chain with the aim to manufacture nuclear components in South Africa in the future.

The Integrated Resource Plan for Electricity for South Africa (generally referred to as the IRP2010) identified nuclear power as an important contributor to the total electricity mix of the future. It is planned to add 9.6 GW of electricity generated by nuclear power to the national grid by 2030. This implies that six to eight new nuclear power plants (NPPs) need to be built in South Africa. Nuclear technology localization and local content will be very important factors in the realization of the nuclear new-build programme.

Zirconium alloys are used as cladding material of the nuclear fuel in NPPs. All the zirconium metal that is used in this application is extracted from the mineral zircon, of which South Africa is the second-largest producer in the world. The NMDN has developed a unique plasma and fluoride beneficiation process to manufacture nuclear-grade zirconium metal powder from locally mined zircon. Hafnium is always associated with zirconium in nature, but it has to be separated from zirconium due to its high thermal neutron absorption cross-section. This property of hafnium is, however, being exploited by the nuclear industry in applications where absorbance of neutrons is required. Apart from its nuclear applications, hafnium is also used in electronics, optics, high-temperature-resistant ceramic materials, and in the aerospace industry. The NMDN has consequently also embarked on the development of hafnium products for nuclear and non-nuclear applications.

The unfortunate Fukushima incident is still fresh in the minds of everybody. High temperatures and rapid oxidation of the zirconium cladding material in contact with the coolant water led to the generation of hydrogen gas and the spectacular hydrogen explosions that were witnessed by everyone on television. Since then, there has been a major drive in the nuclear industry to make zirconium alloys more resistant to oxidation at high temperatures. The application of zirconium carbide and silicon carbide layers on zirconium nuclear fuel tubes is but one of the research programmes that the NMDN is pursuing in this regard.

Thorium is envisaged to be an important nuclear fuel for the future Generation IV high-temperature gas-cooled nuclear reactors or molten salt nuclear reactors. The mineral monazite contains a significant concentration of thorium along with valuable rare earth elements (REEs) such as neodymium (Nd), cerium (Ce), praseodymium (Pr) and yttrium (Y). Nd, for example, is a crucial ingredient in permanent magnets that are used in wind turbines to generate electricity. Monazite is a by-product from the heavy mineral sand industry in South Africa, and is also found in hard-rock orebodies, for example at Steenkampskraal and Zandkopsdrift in the Western Cape Province. Monazite, a rare earth phosphate, is extremely chemically inert. Conventional chemical extraction procedures are very harsh, environmentally unfriendly, and produce radioactive waste. The NMDN is investigating new plasma fluoride beneficiation methods to recover the REEs and to separate the contained thorium and uranium values.

Human capital development forms a fundamental pillar of the AMI. In 2015, the NMDN has 28 postgraduate students enrolled at various universities in South Africa to contribute to the building of a sound local knowledge base in nuclear technology. The participation of these universities in the NMDN projects is highly appreciated. The postgraduate students of the NMDN express their extreme gratitude towards the DST for creating this programme as a launching platform for their careers.

The papers that are published in this special journal of the *Journal* are a selection from the papers that will be presented at the 2015 academic peer-reviewed process of the AMI, of which this conference is the grand finale for postgraduate students. This year it is being hosted by the NMDN and will take place at the Nelson Mandela Metropolitan University in Port Elizabeth from 28–30 October 2015. It is noteworthy that this is the first time in the history of the AMI that the special edition of the *Journal* that is dedicated to the annual AMI conference will be published ahead of the conference. In this regard the Chairman thanks the organizing committee of the conference, the referees, and the SAIMM publications team for their hard work towards achieving this historic goal.

The NMDN and Necsa express their sincere gratitude towards the Honourable Minister Naledi Pandor and the Honourable Director General of the Department of Science and Technology, Dr Phil Mjwara, for their continuing support of the AMI and the NMDN over many years.

I hope that everyone will find the conference an enjoyable event and that this special edition of the SAIMM Journal will constitute a major contribution to the nuclear science and engineering fraternity of South Africa.

J.T. Nel
NMDN Coordinator and Conference Chairman