



# PROCEEDINGS

## The Conference of the South African Advanced Materials Initiative 2021 (CoSAAMI'21)

Ronald Machaka and Jaco van der Walt



## Introduction

The Chair of the Technical Committee is pleased to present the proceedings of the Conference of the South African Advanced Materials Initiative (CoSAAMI'21). These proceedings are composed of a variety of contributions from researchers, engineering firms, consultants, nuclear industry associations, regulators and postgraduate students presented at the CoSAAMI'21 conference held virtually from the 18<sup>th</sup> to 21<sup>st</sup> of October, 2021. The conference is an evolution of the Advanced Materials Initiative (AMI) series of conferences which offered a platform for researchers and students from the AMI networks, Light Materials Development Network (LMDN), Ferrous Materials Development Network (FMDN), Precious Materials Development Network (PMDN) and Nuclear Materials Development Network (NMDN) and researchers globally, to present their work on topics related to the themes of the conference. To guarantee quality, credibility and accuracy of scientific contents, all contributions submitted to CoSAAMI'21 were peer reviewed by a panel of capable referees in accordance with the IOP Peer Review Guidelines. As a result, out of the 64 manuscripts received, a total of 47 papers were accepted for publication. These conference proceedings and all the other scientific presentations related to the CoSAAMI'21 must be attributed to the extraordinary efforts made by the conference's panel of peer reviewers and the tremendous dedication of the CoSAAMI'21 Technical Chair, Dr Jaco van der Walt and his very capable and dedicated team. The unwavering support of the CoSAAMI'21 sponsors are duly appreciated.

Jaco van der Walt, PhD

## Foreword by the DSI

The Advanced Materials Initiative (AMI) was established by the three science councils working in metallurgy and materials science, viz. Mintek, the Council for Scientific and Industrial Research (CSIR) and the South African Nuclear Energy Corporation Ltd. (Necsa). The initiative is supported by the Department of Science and Innovation (DSI) with the purpose of facilitating research, development and innovation across the materials value chain. The goal is to target significant export income and new industries for South Africa through the country becoming a world leader in sustainable materials production and manufacturing via technological competence and optimal, sustainable local manufacturing of value-added products, while reducing environmental impact.

The key objectives of the programme is to create new industries, support existing industries, and localise technology. The AMI takes an integrated (vertical and lateral) approach across the entire value chain from resource development to materials production and the manufacture of end-products, to achieve its goal.

The programme consists of various technology networks, each focussing on different commodities that are of strategic importance to South Africa. The AMI promotes collaborative research between the science councils, tertiary education institutions and industry, both local and internationally. Human resource development is critical for the networks to expand the country's technical capacity, develop the use of materials in new applications and more diverse industries, and develop industrial localisation.

The Conference of the South African Advanced Materials Initiative (CoSAAMI'21) is the culmination of the annual peer review mechanism of the AMI. It particularly encourages the interaction of students and developing academics with the more established academic community and industry in an informal setting to present and discuss new and current work.

## Foreword by the conference chair



The Conference of the South African Advanced Materials Initiative (CoSAAMI) emerged from the Advanced Materials Initiative (AMI) conferences over the past years. The AMI was established by the Department of Science and Innovation together with science councils to promote research and development on materials science acknowledging the country's wealth in minerals. The science councils involved are: The Council for Scientific and Industrial Research (CSIR), Council for Mineral Technology (Mintek) and South African Nuclear Energy Corporation (Necsa).

The local and international researchers as well as students present their research work related to the themes of the conference. The CoSAAMI is traditionally a contact conference held at different provinces in South Africa. However, due the current situation related to the COVID-19 pandemic, the 2020 conference did not take place. This year, CoSAAMI'21 is the first virtual conference and an interesting learning process for all of us. The conference continues to accept papers in powder metallurgy, materials for different engineering applications, computational modelling, corrosion, composites, polymers, nanomaterials, thin films, energy materials, alloy development and sensing materials. This year 96 delegates registered for attendance. It is however difficult to estimate how many will attend the conference because it is impossible to determine how many people will share digital resources.

The papers submitted to CoSAAMI'21 virtual conference were all peer reviewed by respective experts. In total 47 papers were accepted for publication.

I would like to thank Dr. Jan-Rijn Zeevaart, Acting DE, R&D at Necsa, Prof. David Nicholls, who is an expert in nuclear energy, Prof. Deon de Beer from CUT and Prof. Lesley Cornish from the University of the Witwatersrand and Prof. Ronald Machaka from CSIR for agreeing to participate as welcoming-, plenary- and keynote speakers.

The special thanks go to the Department of Science and Innovation for the continued support of the AMI program. Thank you to the CoSAAMI'21 organizing committee comprised of members from all science councils, the technical committee and South African Journal of Natural Science and Technology for publishing our accepted papers. Thank you also goes to our participants and students. We would like to



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appreciate NMISA for the sponsorship and support. We hope this partnership will continue into the coming conferences.

Amogelang Sylvester Bolokang: CoSAAMI'21 Conference chair

## The Committees of the CoSAAMI'21

### CHAIRS OF THE CONFERENCE:

*Conference Chair*

Dr Sylvester Bolokang – sbolokang@csir.co.za

*Conference Co-Chair*

Ms Jakkie Postma – jakkie.postma@necsa.co.za

### CONFERENCE SECRETARIES:

CSIR: Mary Mojalefa - MMojalefa@csir.co.za

Necsa: Prudence Ramashidzha - Prudence.Ramashidzha@necsa.co.za

### ADVANCED MATERIALS INITIATIVE NETWORKS:

Light Materials Development Network, CSIR
Titanium Centre of Competence, CSIR
Precious Materials Development Network, MINTEK
Ferrous Materials Development Network, MINTEK
Nuclear Materials Development Network, Necsa

### LOCAL ORGANIZING COMMITTEE:

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Wilna du Plessis	AMI	Department of Science and Innovation
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Prudence Ramashidzha	Conference Secretary	Council for Scientific and Industrial Research
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Jakkie Postma	Co-Chair	South African Nuclear Energy Corporation
Sagren Govender	Advisor	Council for Scientific and Industrial Research
Jaco van der Walt	Technical chair	South African Nuclear Energy Corporation
Hertzog Bissett	Sponsorships Chair	South African Nuclear Energy Corporation
Steven Lötter		South African Nuclear Energy Corporation
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Rosinah Modiba		Council for Scientific and Industrial Research
Marandela Mulaudzi		Council for Mineral Technology

Keneiloe Sikhwivhilu		Council for Mineral Technology
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Ntsoaki Mathabathe		Council for Scientific and Industrial Research
Miemie Maminza		Council for Scientific and Industrial Research
Milton Makhofane		South African Nuclear Energy Corporation

## ADJUDICATORS

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Wilna du Plessis	Department of Science and Innovation
Mahlori Mashimbye	Department of Science and Innovation
Alufelwi Tshavhungwe	Department of Science and Innovation
Clife Oliphant	National Metrology Institute of South Africa
Siggibo Camagu	Council for Scientific and Industrial Research
Kalenda Mutombo	Council for Scientific and Industrial Research
Zizo Gxowa	Council for Scientific and Industrial Research
Jabulani Gama	South African Nuclear Energy Corporation
Tryphine Nhlabathi	South African Nuclear Energy Corporation
Joseph Moema	Council for Mineral Technology
Alain Mwamba	Council for Mineral Technology
Maje Phasha	Council for Mineral Technology

## List of Reviewers

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Dr Sylvester Bolokang	Council for Scientific and Industrial Research
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Jakkie Postma	South African Nuclear Energy Corporation
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Prof Oliver Damm	Stellenbosch University

The Chair of the Technical Committee of the CoSAAMI'21 conference would like to express gratitude to all reviewers for the volunteering support and contribution in the editing and reviewing process.



## Plenary speaker



## **DAVID RICHARD NICHOLLS**

**Pr.Eng., C.Eng., FSAIEE, MINucE, BSc(Hons), Dip.Nuc.**

**Date of Birth: 23 March 1954**

### **Short Biography:**

Mr Nicholls started his career in the Royal Navy, joining at the age of 17 in 1971. He gained his engineering degree and post graduate nuclear qualifications before serving as an engineer officer in nuclear submarines. He left the navy in 1982 to manage a small family manufacturing company for two years before emigrating to South Africa in 1984 to join Eskom.

He arrived in Eskom as the Koeberg nuclear reactors were being commissioned and started his Eskom career in the Safety and Licensing section of the Nuclear Engineering department at head office in Megawatt Park. During most of his 34 years in Eskom, up to his retirement in December 2018, he remained in the nuclear field. He retired from Eskom as the Chief Nuclear Officer, responsible for all nuclear activities in the company.

The major highlights of David's time in Eskom were the creation and management of the Pebble Bed Modular Reactor (PBMR) project, the establishment of the corporate nuclear safety oversight organization and the technical leadership of the program for nuclear new build from 2007.

Since retiring in 2018 he has been a seasonal lecturer in Nuclear Engineering at the University of Witwatersrand. He was appointed as the Chairperson of the Board of the South African Nuclear Energy Corporation (Necsa) in January 2020 and in October 2020 he was appointed as a Professor of Practice in the Faculty of Engineering and the Built Environment by University of Johannesburg.

Internationally he was the Chairman of the IAEA Technical Working Group on Light Water Reactors from 2010 to 2016 and is currently the Co-Chair of the IAEA Technical Working Group on Nuclear Power Plant Operations. He was a member of WANO's Post-Fukushima Design Review Team from 2012 to 2018.

## Keynote speakers



## Prof. Deon de Beer:

**DSI/merSETA Chair: Innovation and Commercialisation of AM, CRPM,  
Central University of Technology, Free State**

### Short Biography:

Deon started his career at UCOR in 1979 and joined the Technikon Free State (TFS) in 1997, where he held several positions. During his tenure at the TFS/CUT, he spent a sabbatical at MATTEK, CSIR in 1995, to start a research project on Rapid Prototyping, to assess industry perceptions and needs through focussing on the role of Rapid Prototyping to support Concurrent Engineering in South Africa, under the leadership of the late Dr Neville Comins and Prof Willie du Preez. Involvement in Rapid Prototyping/Additive Manufacturing R&D changed his future, and led to various other opportunities at the CUT, VUT, and NWU, before returning to CUT in 2018, in addition to be involved in new national initiatives and networks locally and internationally. Deon believes in empowering others while maintaining personal excellence and leading by example. One of his personal objectives is continuous promotion and education of AM and its innovation and commercialisation in SA and beyond.

### Abstract:

Initially termed Rapid Prototyping or 3D Printing, Additive Manufacturing (AM) started in 1990 in South Africa. Being a disruptive technology, AM led to significant advancement in a broad range of industries and application areas, especially due to constant development and improvement of industry relevant consumable materials. Through various forms of public and private funding support, an informal ecosystem started to develop, which amongst others, led to the formation of the Rapid Product Development Association of South Africa (RAPDASA). Since RAPDASA's inception in 2000, its primary objective was to convince the South African industry of the importance of AM for maintaining international relevance and competitiveness. Starting from a zero base, the use of AM grew at a significant rate. In many ways, it realised the goals set through the then DACST's National Research and Technology Foresight Project (1998), where AM was listed as one of the key future technologies to be pursued. RAPDASA and the CSIR through the National Laser Centre, the Materials Science and Manufacturing unit and recently the CSIR Manufacturing Cluster and various foci under the Advanced Manufacturing Technology Strategy and

various sub-programmes such as the Ti Centre of Competence (supported by the DSI), also became the vehicle for the SA AM Road Map, followed by the SA AM Strategy. Sequential development led to the Collaborative Programme on Additive Manufacturing, which by its nature and continued support, became an AM Ecosystem in South Africa, recognised internationally. An interesting challenge (and goal) is to apply lessons learned beyond the SA borders into SSA and the rest of Africa. The paper will discuss recent successes achieved through a SAIS-funded project in Botswana, and future possibilities to replicate lessons learned in the rest of Africa.



## Prof. Lesley Cornish, PhD

### Short Biography:

**Director: DSI-NRF Centre of Excellence in Strong Materials, and Professor in the School of Chemical and Metallurgical Engineering, University of the Witwatersrand, Johannesburg, South Africa**

**Director: ARUA Centre of Excellence in Materials, Energy and Nanotechnology (CoE-MEN)**

Prof. Lesley Cornish obtained her BSc (Metallurgy and Materials), MSc (Computer Science) and PhD (Metallurgy and Materials) from the University of Birmingham, UK. She is a Physical Metallurgist who has worked in phase diagrams since the beginning of her PhD. She has been working on alloy development almost continually since then, and has worked for the United Kingdom Atomic Energy Authority, University of the Witwatersrand and Mintek. Her research has focused on alloy development, including platinum-based alloys, cermets, as well as the derivation of phase diagrams. As part of the alloy development work, she also works with characterisation techniques, and well as mechanical properties and corrosion.

She was the Director of the African Materials Science and Engineering Network (AMSEN), which was funded by the Carnegie Corporation of New York from 2009 - 2016. Prof. Cornish is currently supervising or co-supervising 12 post graduate students, mainly at the University of the Witwatersrand, with 36 MSc and 29 PhD students already graduated. She has lectured to all undergraduate years in Metallurgical Engineering since 1990, postgraduate courses, and has given external courses on phase diagrams, heat treatment and lectures in the UK, USA, Zimbabwe, Botswana, Germany and Nigeria, and given courses to De Beers, Mintek, and Necsa. In 2017, she completed a Postgraduate Diploma in Education, *cum laude*.

Her awards include six best published paper awards using electron microscopy by the Microscopy Society of Southern Africa (MSSA) Conference, and she or her students have won awards for presentations at the MSSA conference eight times. She has

three Materials Science International Team Certificates: 2006, 2007 and 2009; and won the (University of the Witwatersrand) Vice-Chancellor's Teaching Award in 1998, and won the Supervision Award: Faculty of Engineering and the Built Environment, in recognition of outstanding contributions to postgraduate supervision in 2015. She became a Fellow of the Royal Society of South Africa in 2010, and a Fellow of the South African Academy of Engineers (SAAE), 2021. She was part of the team that was a R&D Magazine 2011, R&D 100 Winner, for Novel platinum/chromium alloy for the manufacture of improved coronary stents, for work done at Mintek; and won the National Science and Technology Forum "Eskom Research Capacity Award", 2013; as well as being in the team that won the "Communication and Outreach for Creating Awareness Award", with Profs. A. Quandt and D. Naidoo, and Ms C.K. Sparkes, in the National Science and Technology Forum-South32 Awards, 2016 – 2017. She was Second runner-up for Distinguished Women Researchers Natural (Physical and Life) and Engineering Science South African Women in Science in 2019.

Prof. Cornish has over 140 papers in refereed journals, as well as over 250 conference proceedings, 2 book chapters, and over 60 technical reports. She has been a member of the Materials Science International Team since 2000, and as well as the 34 phase diagram reviews published in books, she has also published about 30 system reports on the MSI website.

She regularly reviews papers for local and international journals and is a Member of the Editorial Board of Journal of Mining and Metallurgy B, and the International Journal of Refractory Metals and Hard Materials. She has been a Committee Member for both local and overseas conferences, and a member of three government delegations: China and Japan in 1999, India in 2002 and USA in 2014. She has also been on NSTF Adjudication Panel for the NSTF-South32 Awards.

When not working, she used to enjoy travelling to places without cell phone coverage, and is a very keen birder. She also is a keen photographer, especially of wildlife. She is an Honorary Officer for the North West Parks and Tourism Board, and has had the privilege of working with rhinos, lions and wild dogs.

### **Abstract:**

## **New materials for future applications: Materials development and properties**

DSI-NRF Centre of Excellence in Strong Materials, hosted by the University of the Witwatersrand, Johannesburg,

South Africa School of Chemical & Metallurgical Engineering, University of the Witwatersrand

ARUA CoE Materials, Energy and Nanotechnology

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The need for new and changed materials will be discussed, covering the properties that must be considered, which are more than those properties measured in the lab or



calculated. Using Pt-based alloys as a major example, as well as Ti-based alloys with Cu additions, methods of evaluation will be explored. Looking wider than these cases, the role of modelling and experimentation will be discussed showing how they should be complementary. The necessity of different techniques and meaningful collaboration will be shown, and the ARUA CoE in Materials, Energy and Nanotechnology will be introduced.



## Prof. Ronald Machaka

### Short Biography:

Ronald Machaka is a CSIR Principal Researcher, a University of Johannesburg visiting associate professor, and a National Research Foundation C-rated researcher.

At the CSIR, Ronald leads powder metallurgy research with a focus on the low-cost development of high-value addition manufacturing processes. Within the Titanium Centre of Excellence (TiCoC), his speciality is titanium advanced manufacturing – he has developed processes and products including the Metal Injection Moulding (MIM) process of making parts from spherical powder and led the invention of methods of making new powder for additive manufacturing (patent filed). He is currently leading efforts to commercialize MIM technologies at the CSIR.

Ronald has successfully supervised numerous honours projects, graduated thirteen masters students, graduated three doctoral candidates who are highly productive researchers, he currently mentors two postdocs under the DST-NRF Professional Development Program Block Grant, and he has supervised and mentored junior staff members to promotion at the CSIR.

Before joining the CSIR, Ronald worked as a Materials Scientist at Element Six, Springs (SA). His area of specialization was diamond grits and diamond crystallization. He studied at the University of Witwatersrand on an Andrew Mellon Foundation merit award where he submitted his PhD thesis by publication.

Some of Ronald's more recent interests include the development and characterization of beta titanium alloys and the application of machine learning for predictive data analytics for high-entropy alloys.

### Abstract:

#### **Metal Injection Moulding at the CSIR: Lessons on Process Development and Commercialization**

<sup>1</sup> *Advanced Materials Manufacturing, Manufacturing Cluster, Council for Scientific and Industrial Research, P.O. Box 395, Pretoria, 0001, South Africa,*

<sup>2</sup> *School of Mining, Metallurgy and Chemical Engineering, University of Johannesburg, Johannesburg, South Africa*

Metal injection moulding (MIM) is an attractive advanced manufacturing technique that in recent years has developed rapidly as a kind of Powder Metallurgy (PM) near-net shaping technology. The MIM process is suitable for the cost-effective manufacturing of high-volume production of intricately shaped parts where high-dimensional accuracy is required. The development and localization of associated MIM intellectual property were identified as a key enabling technology in the beneficiation of South Africa's vast titanium resources under the Advanced Materials Initiative (AMI) and Titanium Centre of Competence (TiCoC) programmes.

This paper will offer insights into the CSIR's successes with the MIM process and product developments and draw lessons to be learnt from our ongoing efforts to commercialize various MIM technologies.



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## **Main Sponsors**



## THE NATIONAL METROLOGY INSTITUTE OF SOUTH AFRICA

The National Metrology Institute of South Africa (NMISA) was established under the Measurement Units and Measurement Standards Act, No 18 of 2006, known as the measurement Act and provides the following:

- Use of measurement units of the international system of units (SI) and certain other measurements
- Designation of the national measurement units and standards
- Keeping and maintenance of the national measurement standards and units
- Establishment and functions of NMISA

NMISA's vision is to be the leading Metrology Centre of excellence on the African continent connecting Africa to the world. Its mission is to consistently deliver outstanding innovative and internationally comparable measurement solutions that support Regional and International trade, people's quality of life and enable the protection of the environment.

### **Accurate and Internationally Acceptable**

The role of NMISA is to ensure that measurements performed, both nationally and regionally, are accurate and internationally acceptable. This enables trade, component manufacturing, the legal acceptance of measurement in environmental monitoring and safety and is crucial for health care.

As the custodian of the national measurement units and national measurement standards (NMS), NMISA maintains and ensures the appropriate application of the international system of units (SI) and other measurement units as defined by NMISA, in consultation with the measurement community, for the country. NMISA also keeps, maintains, and disseminate the gazetted NMS.

This role is performed through various products and services and is influenced by the external environment. The trade of goods and services around the world is the

lifeblood of the global economy and is increasingly important for domestic economic growth, productivity, and investment opportunities. For customers to consider trade to be effective and efficient and for effective health care and the protection of the environment, measurements taken in different parts of the world need to be accurate, equivalent to and accepted by each other. Important decisions (economic, environmental, social, and medical) are based on measurement results.

### **Measurement Assist with South Africa's Industry Competitiveness**

South Africa has developed a quality infrastructure over a period of 70 year to support its trade, the manufacturing industry and to provide an essential component of environmental health and safety and effective law enforcement. The global and domestic situation is changing fast with new technological advances and a looming African Continental Free Trade Area (AfCFTA).

NMISA has organised activities into thematic, multidisciplinary research programmes that will deliver outcomes such as improved NMS or measurement solutions to industry. These programmes are:

#### **Energy efficiency**

- Solid state lighting
- Smart grids
- Power and energy
- ACDC transfer difference measurements

#### **Units, NMS and measurement capabilities**

- Watt balance
- Avogadro project
- Quantum standards

#### **Reference Materials**

- Food and feed matrix reference materials
- Forensic and environmental reference materials
- High purity calibrators
- Mineral beneficiations

#### **Quality of life**

- Cancer age
- Pharmacology
- Primary health care
- Occupational health and safety

#### **Advanced measurement solutions**

- Time reference signals (MeerKAT)

#### **Manufacturing competitiveness**

- Thin film failure analysis
- Dimensional measurements
- Advanced manufacturing and torque

### **Green economy**

- Air, terrestrial and aquatic monitoring
- Industrial and applied monitoring
- Alternative technology

### **Commercial services**

- Law enforcement
- Radiation protection
- Sale of CRMs
- Calibration services

NMISA is part of the Department of Trade, Industry and Competition's (**the dtic**), family of the Technical Infrastructure (TI) Institutes, which also include the South African Bureau of Standards (SABS), National Regulator for Compulsory Specification (NRCS) and the South African National Accreditation System (SANAS), that together provides for confidence in local goods and products and allows for successful prosecution in cases of non-compliance.

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## **Mandate**

The South African Nuclear Energy Corporation SOC Limited (Necsa) is mandated to undertake and promote research and development (R & D) in the field of nuclear energy and radiation sciences and technology.

The company is also responsible for processing source material, special nuclear material and restricted material and to reprocess and enrich these.

Subject to approval by the Minister of Energy, who is the sole shareholder representing the South African Government, Necsa co-operates with any person or institution in matters falling within its mandated functions.

Necsa is committed to carrying out its mandate in a manner that strictly adheres to all the measures that are put in place to protect the environment and the people of South Africa.

## **Vision**

To pursue nuclear technology excellence for sustainable social and economic development.

## **Mission**

To develop, utilise and manage nuclear technology for national and regional socio-economic development through:

- Applied R&D
- Commercial application of nuclear and associated technology



- Contributing to the development of skills in science and technology
- Total commitment to health, safety and care for the environment
- Developing and empowering our human resource base
- Fulfilling the State's nuclear obligations
- Satisfying stakeholder expectations.

## **Business**

Necsa is responsible for processing source material, including uranium enrichment, and co-operating with other institutions, locally and abroad, on nuclear and related matters for the promotion of socio-economic development in South Africa as well as R&D in the field of nuclear energy and radiation sciences.

Apart from its main activities at Pelindaba, which include operation and utilisation of the SAFARI-1 research reactor, Necsa also manages and operates the Vaalputs National Radioactive Waste Disposal Facility in the Northern Cape on behalf of the National Radioactive Waste Disposal Institute (NRWDI).

Necsa engages in commercial business mainly through its wholly-owned commercial subsidiaries NTP Radioisotopes SOC Ltd (NTP), which is responsible for a range of radiation-based products and services for healthcare, life sciences and industry, and Pelchem SOC Ltd (Pelchem), which supplies fluorine and fluorine-based products. Both subsidiaries, together with their subsidiaries, supply local and foreign markets, earning valuable foreign exchange for South Africa.

## **Origins**

South Africa's foray into nuclear research and development started in 1944 following a request by the United Kingdom for assistance in obtaining uranium. After World War II, interest in the extraction of uranium oxide continued from the USA and UK for medical and economic purposes in addition to military use.

This led to the establishment in February 1946 of the "Uranium Research Committee" and in September 1948, the South African Atomic Energy Board (AEB) was constituted. Following international developments in nuclear power and radioisotope applications, construction of the National Nuclear Research Centre, including the SAFARI-1 Research Reactor, started at Pelindaba in 1961.

Nearly ten years later, in 1970, the Uranium Enrichment Corporation (UCOR) was created and tasked to establish a nuclear fuel cycle programme at Valindaba, adjacent to the then Pelindaba site. The ostensible aim was to investigate the feasibility of nuclear explosives for non-military applications. However, due to a growing global nuclear threat, the emphasis

changed in 1977 to a strategic nuclear weapons deterrent capability and in November 1979 South Africa's first nuclear device was equipped with highly enriched uranium.

The application of nuclear technology in civilian nuclear power generation really took off in 1978 with construction of the "Z" Enrichment Plant in Pelindaba, approximately 30km west of Pretoria. A fuel element manufacturing facility for Koeberg Nuclear Power Station started production about a decade later in 1987.

Meanwhile, the Nuclear Energy Act of 1982 renamed the AEB to NUCOR and combined it with UCOR under the Atomic Energy Corporation (AEC) as controlling body. On 1 July 1985, the NUCOR and UCOR subsidiaries were combined into the Atomic Energy Corporation. The current Nuclear Energy Act transitioned the AEC to the South African Nuclear Energy Corporation – Necca.

## COSAAMI'21 TECHNICAL PROGRAMME

Meeting link: <https://zoom.us/j/96731358215>

Monday, 18 October 2021

<b>DAY 1</b>		<b>OPENING SESSION</b>			
	<i>Session Chair:</i>	<i>Jaco van der Walt</i>			
09h00 -09h05	Opening	Sylvester Bolokang - Chairperson, CoSAAMI 2021			
09h05 – 09h25	Welcome Address	Beeuwen Gerrys – Chief Director, Technology localisation, beneficiation and advanced manufacturing, DSI			
09h25 – 09h40	Opening Address	Jan-Rijn Zeevaart – Acting Divisional Executive, R&D, Necsa			
<b>DAY 1</b>		<b>PLENARY SESSION</b>			
	<i>Session Chair</i>	<i>Jaco van der Walt</i>			
09h45 – 10h45	Plenary	David Nicholls – Chairman of the Board, Necsa			
10h45 – 11h05	Sponsor Presentation	NMISA Presentation			
11h05- 11h30		TEA BREAK			
<b>DAY 1</b>		<b>SESSION 1</b>			
		Advanced Manufacturing	Metallic Materials	Nanomaterials	Novel Energy Materials
<i>Session Chair</i>		<i>Milton Makhofane</i>	<i>Ronald Machaka</i>	<i>Keneiloe Sikhwivhilu</i>	<i>Ntsoaki Mathabathe</i>

11h30 - 11h50	<b>167. Sadiq Abiola Raji</b> Influence of Mo on Microstructure and Hardness of Ti-Al-Si Alloy Processed by Laser Engineered Net Shaping (LENS)	<b>241. Maje Phasha</b> An overview of the Ferrous Materials Development Network (FMDN) in South Africa	<b>172. Tshogfatso Phaahla</b> The Effect of Doping with M (M = Ir AND Pt) Impurities on Ti Clusters: A Density Functional Theory Study	<b>220. Nkgaphe Tsebesebe</b> Empirical Forcefield Derivation and Implementation for LiMO <sub>2</sub> (M: Ni, Mn, CO) Cathode Materials
11h50 - 12h10	<b>145. Nthateng Nkhasi</b> Reconditioning of Ti6Al4V Powder Through an Inductively Coupled Plasma for Direct Metal Laser Sintering	<b>235. Lebedike Mampuru</b> Comparative evaluation of wear properties of alloyed 25 wt% chromium white cast iron for milling environments	<b>166. Ntsoaki Mphuthi</b> Optimization of surfactant use in shear exfoliation of 2D MoS <sub>2</sub> nanosheets	<b>178. Brian Ramogayana</b> The Effect of Niobium Doping on Major Surfaces of Lithium Manganese Oxide (LiMn <sub>2</sub> O <sub>4</sub> ): DFT Study
12h10 - 12h30	<b>150. Mattheus Gerhardus Willems</b> Material characteristics of additively manufactured Ti-6AL-4V samples using the laser based direct energy deposition technique.	<b>236. Vuyo Motsweni</b> Effect of process control agent (PCA) on the properties of mechanically alloyed Al-Cu powders	<b>227. Magdeline Mohlao Seabi</b> Hydrothermal Zinc Oxide Nanoparticles as Seeds to Induce Nanoripples in Zinc Oxide Thin Films	<b>183. Percy Ngobeni</b> Structural and Electronic Properties of $\beta$ -MnO <sub>2</sub> Employing DFTB Technique
12h30-13h30	<b>LUNCH</b>			
<b>DAY 1</b>	<b>SESSION 2</b>			
	<b>Advanced Manufacturing</b>	<b>Metallic Materials</b>	<b>Nanomaterials</b>	<b>Design &amp; Simulation</b>
<i>Session Chair</i>	<i>Hertzog Bissett</i>	<i>Zizo Gxowa</i>	<i>Rosinah Modiba</i>	<i>Milton Makhofane</i>
13h30 - 13h50	<b>160. Modupeola Dada</b> In-situ Reactive Synthesis of High Entropy Alloys by Laser Metal Deposition for Aerospace Applications	<b>204. Rabelani Tshidavhu</b> Microstructural analysis of as-cast NdFeB magnetic alloy	<b>192. Khanyisile Masemola</b> Tuning the physiochemical properties of carbon dots via heteroatom doping: Effects of the concentration of nitrogen-containing precursor.	<b>143. Thinus van Rhijn</b> Towards Predicting Process Parameters for Selective Laser Melting of Titanium Alloys Through the Modelling of Melt Pool Characteristics

13h50 - 14h10	<b>173. Gaofengwe Molatlhegi</b> The effect of laser surface re-melting on the surface roughness and micro-hardness of selective laser melting (SLM) fabricated Ti-6Al-4V samples.	<b>237. Lesego Miya</b> Investigating the electronic and magnetic properties of Dy, Y and La by site substitution on Nd <sub>2</sub> Fe <sub>14</sub> B permanent magnet employing the first principle approach.	<b>165. Lindokuhle Magagula</b> Synthesis of cellulose-based nitrogen-doped carbon quantum dots for the detection of Fe(III)	<b>144. Themba Mashiyane</b> Influence of operating speed on the thermo-mechanical behaviour of cylindrical roller bearing
14h10 - 14h30	<b>202. Smith Salifu</b> Determination of the dominant failure mechanism of P92 steam piping subjected to daily operational cycle using finite element (FE) technique	<b>239. Christiaan Pretorius</b> Evaluation of the HTHA-Kinetics in Welded C-0.5Mo Steels during Accelerated Laboratory Testing using High-Temperature Capsule Strain-Gauges	<b>196. Martin Aluga</b> Synthesis of SiO <sub>2</sub> , Fe <sub>2</sub> O <sub>3</sub> AND Al <sub>2</sub> O <sub>3</sub> Nanoparticles from Lignocellulosic Bio-Pozzolans	<b>185. Seya Watano Alex</b> Impact of Heat and Mass Transfer on Spheroidization of Titanium Alloys
14h30 – 14h50				<b>200. Zakhele Mathews Zondi</b> Characteristics of the asymmetric Stockbridge damper

END OF DAY

Meeting link: <https://zoom.us/j/96731358215>

Tuesday, 19 October 2021

DAY 2		KEYNOTE SESSION
	Session Chair	Sagren Govender
09h00-10h00	Keynote	<b>Prof Lesley Cornish</b> New materials for future application: Materials development and properties
10h00-10h20		<b>161. Nehru Pillay</b> South African Platinum Group Metals Industry Roadmap Project Overview

10h20 - 10h50	TEA BREAK			
DAY 2	SESSION 1			
	Advanced Manufacturing	Metallic Materials	Nanomaterials	Novel Energy Materials
Session Chair	Sylvester Bolokang	Ryno van der Merwe	Miemie Maminza	Marandela Mulaudzi
10h50 - 11h10	<b>177. Andile Mazibuko</b> The Stability of Titanium Clusters Tin (n=5,13,19) in LiCl Medium	<b>164. Hein Moller</b> Overview of the Precious Materials Development Network (PMDN)	<b>211. Obakeng Nchoe</b> Coalescence of Nano-enhanced Reverse Osmosis Membranes with Antifouling Properties	<b>190. Refiloe Maphoto</b> Computational Modelling Study of on the Stability of Li <sub>7</sub> La <sub>3</sub> Zr <sub>2</sub> O <sub>12</sub> (LLZO) Solid Electrolyte for Lithium Ion Batteries
11h10 - 11h30	<b>187. Nthabiseng Moshokoa</b> Microstructure and Mechanical Properties of As-Quenched Metastable Binary Ti-Mo Alloys	<b>148. Tshenolo Phinah Leso</b> Study of Wear Performance of Wheel and Rail Pearlitic Steels Under Dry Sliding Conditions	<b>170. Rudzani Ratshiedana</b> Photodegradation of Tartrazine Using Silver Doped Titanium Dioxide	<b>152. Khomotso Maenetja</b> Density Functional Theory Study of MnO <sub>2</sub> , TiO <sub>2</sub> and VO <sub>2</sub>
11h30 - 11h50	<b>195. Nana Arthur</b> Heat Treatment of Ti6Al4V Alloyed With Beta Stabilizers	<b>153. Tshedza Sithuba</b> The Study of the Effects of Flavanoid Derivatives as Corrosion Inhibitors for Zinc in Sulphuric Acid	<b>240. Masaku Kgatle</b> Degradation Mechanism of Methyl Orange Dye Using Fe/Ag/Zn Trimetallic Nanoparticles	<b>230. Jane Negondeni</b> Synthesizing Pt-Ni Nanoframe electrocatalysts using the solvothermal and in-house developed method for PEM fuel cells
11h50 - 12h10	<b>248. Monnamme Tlotleng</b> Laser micro in situ alloying of Manganese to $\beta$ -Ti46.8Al1Cr0.2Si	<b>156. Dyal Ukabhai</b> Thermo-mechanical processing and phase analysis of titanium alloys with copper additions	<b>243. Kgolofelo Malatjie</b> Iron-doped cerium oxide/graphene oxide nanocomposites for the degradation of organic pollutants from wastewater	<b>229. Nkateko Mkhabela</b> Development of ATO as an alternative catalyst for PEM fuel cells

12h10 - 12h30	<b>245. Kim Beyl</b> Effect of surface preparation techniques on hybrid investment cast-additive manufactured Ti-6Al-4V components	<b>163. Vinod Kurup</b> Study of one-step and two-step quench and partition heat treatments on a medium carbon high silicon alloy using dilatometry		
12h30-13h30	<b>LUNCH</b>			
<b>DAY 2</b>	<b>SESSION 2</b>			
	<b>Computational &amp; Data Driven Modelling</b>	<b>Metallic Materials</b>	<b>Plasma &amp; High Temperature Technology</b>	
<i>Session Chair</i>	<i><b>Ntsoaki Mathabathe</b></i>	<i><b>Joseph Moema</b></i>	<i><b>Jaco van der Walt</b></i>	
13h30 – 13h50	<b>203. Bongani Ngobe</b> First-principles technique is employed to explore possibility of inducing martensitic transformation in ordered B2-TiRu phase by alloying with Pd	<b>223. Absalom Mabeba</b> Effect of Post Weld Heat Treatment of the Fatigue Strength of AISI 430	<b>149. Rearabetswe Dire</b> Characterisation of Spheroidised Tungsten Carbide Metco 32C Powder Using Radio Frequency Plasma	
13h50 - 14h10	<b>159. Vilet Semakaleng Hilane</b> Mechanical properties and thermodynamics functions of Ni-based alloys for high temperature corrosion resistance	<b>224. Seyed Reza Jafarpour Rezaei</b> The influence of austenitization time and temperature on the austenite grain growth in high Ti-V HSLA steels	<b>186. Justin Mbwebwe</b> CFD evaluation of conditions before impact of particles in plasma spraying process	
14h10 - 14h30	<b>231. Cherise Thesner</b> Using Site Occupation Disorder to build bulk structures of Ni <sub>x-1</sub> Al <sub>x</sub>	<b>225. Mbavhalelo Maumela</b> The Influence of Alloying Elements on Tensile Strength During Thermo Mechanical Control Process of Aluminum Alloy	<b>222. Hertzog Bissett</b> Reduction of Copper Oxide powder by an inductively coupled thermal plasma	
	<b>END OF DAY</b>			

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Wednesday, 20 October 2021

DAY 3		KEYNOTE SESSION			
09h00 to 10h00	Session Chair	Keneiloe Sikhwivhulu			
	Keynote	Prof. Ronald Machaka Metal Injection Moulding at the CSIR: Lessons on Process Development and commercialization			
DAY 3		SESSION 1			
		Advanced Manufacturing	Metallic Materials	Ceramic Materials	
	Session Chair	Hertzog Bissett	Jakkie Postma	Zizo Gxowa	
10h00 - 10h20	212. Abjesh Rath	Thermal, Mechanical, and Morphological Investigation of Injection Moulded Poly (Trimethylene Terephthalate)/Graphene Oxide/F-MWCNT Hybrid Polymer Nanocomposites	228. Helena Rossouw	The Influence of Al Addition on the Evolution of Microstructures and Texture During Finishing Rolling of AISI 430	180. Bathusile Nelisiwe Masina
10h20 - 10h40	214. Olusegun Afolabi	Effect of Size Distribution and Characterization of Hollow Glass Microsphere/ Epoxy Matrix on Flexural Properties of Syntactic Foam Composites	234. Velile Charmain Mnisi	First principles study of phase stability and elastic properties of $Ti_{94}Mo_{6-x}Zr_x$ (where $x: 2 - 5$ ) for biomaterials.	154. Agnes Modiga
10h40 - 11h00	221. Debasmita Mohanty	Bio-based Polyurethane coating synthesized from Modified Castor Oil- Applicable in Base Coat of Automobile Paint	198. Mphamela Enos Baloyi	Effect of 6.25 at.% Ta on TiPtCo Shape Memory Alloy	193. Raesibe Ledwaba
				Formation of Garnet-Type $Li_7La_3Zr_2O_{12}$ Nanoparticles as an Alternative Structural Stabilization Route	



11h00-11h30	TEA BREAK			
DAY 3	SESSION 2			
	Advanced Manufacturing	Computational & Data Driven Modelling	Ceramic Materials	Materials for Extreme Environment
Session Chair	Ronald Machaka	Mandy Madigoe	Sagren Govender	Sylvester Bolokang
11h30 - 11h50	<b>207. Noluntu Muchavi</b> A shape memory alloy review: Biomedical applications	<b>157. Vongani Chabalala</b> Inputs to Machine Learning: Classification of Metal Oxides using Support Vector Machine and Principal Component Analysis	<b>175. Pushetso Ramasobane</b> In-Situ Synthesis of TiC/Ti-6Al-4V Composite by Direct Metal Deposition	<b>151. Rinae Ratshikombo</b> Study of Corrosion Inhibition Efficiency, Mechanism and Application of Chromones as Corrosion Inhibitors on Mild Steel in Sulphuric Acid
11h50 - 12h10	<b>238. Alain Mwamba</b> Tracking the railway line in-service behaviour through metallurgical, mechanical and wear property characterisation	<b>168. Sadiq Abiola Raji</b> Modelling and Simulation of the Fatigue Usage Factor of $\gamma$ -TiAl Alloy Fabricated through Laser Additive Manufacturing (LAM)	<b>181. Paul Lekoadi</b> Effect of Pre-Heating on Microstructural Evolution and Hardness Properties of In-Situ TiB/Ti6Al4V Composite Produced by Laser Metal Deposition	<b>201. Nomsombuluko Masia</b> Corrosion Performance of Ti-Cu Alloys for Biomedical Applications
12h10 - 12h30	<b>188. Tebogo Ledwaba</b> Cluster Expansion of B2 FeCo <sub>1-x</sub> V <sub>x</sub> and Fe <sub>1-x</sub> CoV <sub>x</sub> Systems	<b>174. Lebogang Motsomone</b> Computational Modelling Studies for High Temperature Monazite Systems	<b>242. Phillip Moloisi</b> Experimental Study on Laser Additive Manufacturing of TiB2/Ti6Al4V Composite	<b>199. Mthobisi Cyprian Zulu</b> Optimization of rotary friction welding process of titanium alloy rods
12h30 - 12h50	<b>246. Percy Ngobeni</b> Structural and electronic properties of $\beta$ -MnO <sub>2</sub> employing DFTB technique.			<b>158. Lindokuhle Magagula</b> Sustainable conversion of corncob biomass waste into economic, high-performance carbon materials
	<b>END OF DAY</b>			
<b>Meeting link: <a href="https://zoom.us/j/96731358215">https://zoom.us/j/96731358215</a></b>				

Thursday, 21 October 2021				
DAY 4	SESSION 1			
	Advanced Manufacturing	Metallic Materials	Nanomaterials	
Session Chair	Rosinah Modiba	Miemie Maminza	Lerato Raganya	
09h00 – 09h20	<b>218. Simphiwe Khanyema</b> Prediction of grain growth during the austenitization of 0.7%C pearlitic rail steel billets	<b>191. Mandy Madigoe</b> Use of first-principles approach and thermo-calc method to identify potential low elastic modulus titanium-based alloy for biomedical applications	<b>146. Sindisiwe Muthwa</b> Colorimetric detection of Mn (II) using 3-(4-hydroxy-3-methoxyphenyl)-2, 3-dihydropyrazolo [3, 4-b] indole-1(4H)-carbothioamide modified gold nanoparticles: A CIEL*a*b*/Yxy colour space study	
09h20 - 09h40	<b>232. Ryno van der Merwe</b> Induction melting of an Al-50Cu alloy for improved homogeneity required for powder spheroidisation	<b>249. Marandela Mulaudzi</b> Effect of different simulated metal dusting environments on Alloys 602CA and 800	<b>182. Tessia Rakgotho</b> Dual application of green synthesis method of zinc oxide nanoparticles; Sorghum bicolor growth and soil sensor development	
09h40 - 10h00	<b>233. Joseph Moema</b> Optimisation of Processing Conditions for Roll-Bonding of AA3003 AND Aa4045 for Heat Exchanger Application	<b>219. Muhammed Salojee</b> Effect of hot rolling parameters on recovery mechanisms in 436 (17%Cr, Nb-Mo) steel	<b>197. Martin Aluga</b> Nanomaterials for Soil Stabilisation in Roads Construction	
10h00 - 10h20	<b>208. Noluntu Muchavi</b> Heat treatment of injection moulded 17-4 PH stainless steel parts	<b>171. Ramogohlo Diale</b> The Effect of Co on the Transformation Temperature and Stability of Ti <sub>50</sub> Pd <sub>50</sub> Alloy	<b>209. Robert Thembinkosi Khumalo</b> Use of Attenuated Total Reflectance Fourier Transform Infrared Spectroscopy as a Tool to Determine Effect of Hot Air Drying on Yield (%) of Chitin from Crab Shells	

<b>10h20 - 10h40</b>		<b>179. David Tshwane</b> Adsorption-Desorption of F2 Diatomic Molecule on Ti (100) Surface	<b>210. Mufaro Moyo</b> Effects of Combined Alkali Treatment and Clay Nanoparticle Infusion on Thermo-Mechanical Response of KENAF/PLA Biocomposites
<b>10h40 - 11h10</b>		<b>TEA BREAK</b>	
<b>DAY 4</b>		<b>KEYNOTE SESSION</b>	
<b>11h10 – 12h10</b>	<i>Session Chair</i>	<i>Hertzog Bissett</i>	
	<b>Keynote</b>	<b>Prof. Deon de Beer</b> Development of Additive Manufacturing Ecosystems in Africa	
<b>DAY 4</b>		<b>CLOSING SESSION</b>	
<b>12h10-13h00</b>	<i>Session Chair</i>	<i>Hertzog Bissett</i>	
	<b>Student Presentation Awards</b>	<b>Sylvester Bolokang</b>	
	<b>Sponsor video</b>	<b>NMISA</b>	
	<b>Vote of thanks</b>	<b>Jakkie Postma</b>	
	<b>Closing</b>	<b>Zizo Gxowa-Penxa (CSIR)</b>	
		<b>END OF CONFERENCE</b>	