Fuel cells to be an energy resource for buildings

Fuel cells are a promising technology for use as a source of heat and electricity in buildings, and as an electrical power source for vehicles.

According to Dr Mkhulu Mathe, manager of the CSIR's energy and processes technology area, fuel cell technology is increasingly being seen as an alternative to traditional power resources with the potential to revolutionise the face of power supply in South Africa.

Fuel cells generate electric power from an electrochemical process using fuels such as hydrogen or methanol. Compared with batteries, fuel cells typically have a higher energy density and a lower weight. In addition, fuel cells are environment-friendly (especially if the fuel is taken from a renewable resource) and can be recharged instantly. Fuel cells are being used in prototype applications to power vehicles, cellular telephones, homes, commercial properties, laptops, household appliances and industrial machinery.

South Africa, as the world's leading producer of platinum (85% of known world reserves), is potentially in a strategic position to take advantage of new opportunities in the fuel cells domain.

Platinum-mediated reactions are at the core of fuel cell technologies. It is, for example, used in the central electro-catalyst layer of proton exchange membrane (PEM) fuel cells. This type is used in automobiles and stationary applications. According to the International Platinum Association, no other material has been shown to be as effective as platinum in PEM fuel cells. Much research is, however, currently directed towards decreasing this dependency on platinum.

The fuel cell research group of the CSIR focuses on direct alcohol fuel cells (DAFC) with speciality in ethanol and methanol micro fuel cells (μDEFC & μDMFC) including hydrogen PEM fuel cells. Research focuses include membrane development, synthesis and characterisation of catalysts, assembly and testing of MEAs. Synthesis of combinatorial catalysts use physical and electrochemical methods, like the electrochemical atomic layer deposition/epitaxy (EC-ALD/E).

Experiments are conducted with different membrane electrode assembly (MEA) architectures, including the electrocatalyst deposition on nafion membranes and the electrocatalyst deposition on the carbon cloth and carbon papers. These studies aim to optimise the hot-pressing conditions and fabrication of three-layered MEAs. The MEAs are characterised for morphology using scanning electron microscope (SEM) and optical microscopy observations, structure with X-ray diffraction (XRD), resistivity by impedance spectroscopy (IS) and electrochemical active area by cyclic voltammetry.

Mathe adds that fuel cell research is a multidisciplinary field and requires expertise in chemistry, engineering and material science, all of which are available in the CSIR, as well as capabilities found at other institutes. Modelling expertise, membrane technology and catalysis require cooperation with the universities of Limpopo, Stellenbosch, North-West and the Witwatersrand, respectively, while electrochemical characterisation and energy scenario modelling require collaboration with the universities of the Western Cape, Pretoria and Cape Town.