

Highlights
Synthesis Gas programme



HIGHLIGHT # 1 – SYNTHESIS GAS PROGRAMME

The relevance of catalysis to the South African economy and the opportunity of catalysis for the South African economy are briefly described below.

The c*change scientific programme is made up of three distinct research programmes, viz.

1. The Synthesis Gas (SYN) Programme
2. The Paraffin Activation (PAR) Programme (cf. Highlight # 2)
3. The RSA Olefins (OLE) Programme (cf. Highlight # 3)

South African Context

South Africa is currently world leader in the area of Fischer-Tropsch synthesis – a process in which synthesis gas is converted into synthetic fuels, e.g. via the so-called coal-to-liquid fuels or gas-to-liquid fuels technologies – and the CoE must ensure that South Africa continues to be the leader in this area and that the technology is developed further to address global sustainability and climate change related challenges. This can be achieved through the adaptation to renewable and alternative feedstocks such as biomass, waste or CO₂. A major challenge in the area of Fischer-Tropsch synthesis is selectivity. The Fischer-Tropsch synthesis is a poorly selective process, in which only partial optimization can be achieved. However, the selectivity towards *classes* of products can be optimized, such as the formation of liquid products (typically defined as C₅₊-selectivity), olefins or oxygenated compounds (alcohols and aldehydes). The primary objectives of the Synthesis Gas Programme are (i) to develop a fundamental understanding of the formation of certain classes of products, (ii) to develop ‘tools’ that are needed to tune product selectivity, and (iii) to develop innovative process configurations utilizing alternative feedstocks.

Impact of the Synthesis Gas Programme

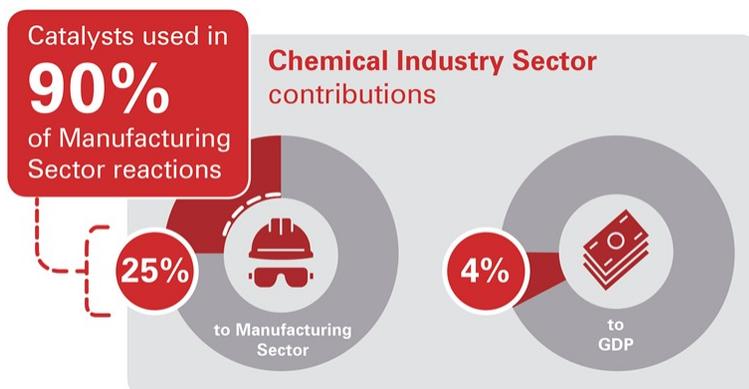
This work is geared towards supporting the RSA chemical industry strengths (see below).

A fundamental understanding of steps of product formation as well as catalyst phase changes under reaction conditions has been achieved allowing for improved catalyst and process design. New selective processes, for example combination of Fischer-Tropsch synthesis and wax hydrocracking or introduction of heteroatoms such as nitrogen, and predictive selectivity models are outcomes of the programme. Building on these strengths the Programme has embarked to also focus on catalytic valorisation of the greenhouse gas CO₂. This has been (and could only be) achieved in a centre-wide collaboration together with international partners and it has secured South Africa world-wide leadership as an academic centre in syngas to fuels and chemicals research.

Relevance of Catalysis to the South African Economy

By its very nature the field of catalysis is environmentally friendly, insofar that catalysis inherently aims to improve the selectivity and yield towards the formation of the desired product(s), thereby reducing the formation of the undesired by-product(s). Moreover, relatively small changes in the desired product yield from a catalytic process ($\pm 1\%$) may translate into substantial economic benefits for an industrial chemical process. Consequently, there is great potential for indirect economic benefit from the research, in that the research supports the South African Chemical Process Industry (SACPI) by studying more efficient chemical transformations, resulting in economically more competitive chemical processes.

Catalysis lies at the heart of the many chemical transformation processes, because approximately 90% of all chemical reactions carried out in commercial chemical industries make use of a catalyst. The purpose of a catalyst is typically to (i) speed up the rate at which the desired product is formed, (ii) form the desired product more selectively, and/or (iii) lower the operating conditions for the reaction. All three of these aforementioned reasons result in improvements of the chemical process and, consequently, in the overall financial performance of the company.



The RSA chemical industry sector contributes about 25% to the RSA manufacturing sector, and this contributes about 4% to GDP.

Opportunity of Catalysis for the South African Economy

South Africa is a net importer of chemical products. The opportunity for the South African Chemical Process Industry is therefore to reduce the trade deficit by (i) increasing the volume of locally manufactured chemical products and reducing imports, or (ii) by adding value to the locally manufactured chemical products, particularly those that are exported.



The c*change research portfolio is geared heavily towards supporting the South African Chemical Process Industry in achieving those objectives.