amts

advanced manufacturing technology strategy

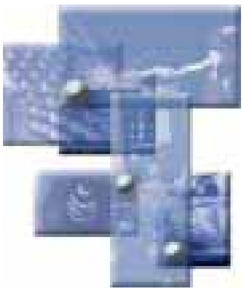
A National Advanced Manufacturing Technology Strategy for South Africa

1st ANNUAL AEROSPACE NETWORK MEETING

26 APRIL 2006

Book of Abstracts

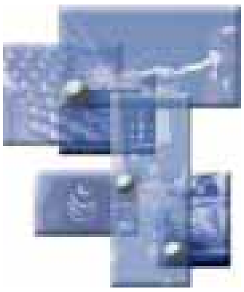
DEPARTMENT OF SCIENCE AND TECHNOLOGY



Space Policy Framework

Mothibi Ramusi, the dti

The **dti** is in the process of developing a Space Policy framework that is meant to serve as platform for a better co-ordination of Space activities and stimulate some business appetite for industry in South Africa. The United Nations expects that all State members that participate in Outer Space matters are expected to do so in a respectable and trustworthy manner. The Republic has also taken a decision to participate in space matters hence forth and as a result the Department of Science and Technology is sponsoring a launch of a South Africa Low Earth Orbit satellite that is to be launched in December 2006 from the Federation State of Russia. The **dti** is therefore expected to provide regulatory support for such initiatives. In so doing, the Minister of Trade and Industry has recently appointed a Space Affairs Council that consists of members from both Government and industry as per the Space Affairs Act, 1993, which empowers the Minister to manage and co-ordinate all Space matters in the Republic.



Development of Investment Casting Capabilities for Complex Light Metals Components

Richard Bean, CSIR MSM

Introduction

This project was proposed under the Advanced Manufacturing Technology Strategy's (AMTS) light weight materials flagship programme. The objective is to perform research that is relevant and that would enhance the capabilities of our existing investment casting industry. Therefore the need for an Investment Casting Interest Group (ICIG) is imperative to ensure industry buy-in and guidance. The ultimate objective is to transfer the research outcomes to industry in the most effective manner. An ICIG was established representing most of the investment casters in SA, users of investment castings (e.g. SAAB Avitronics, Denel, Kentron, Boeing) and tertiary education institutions.

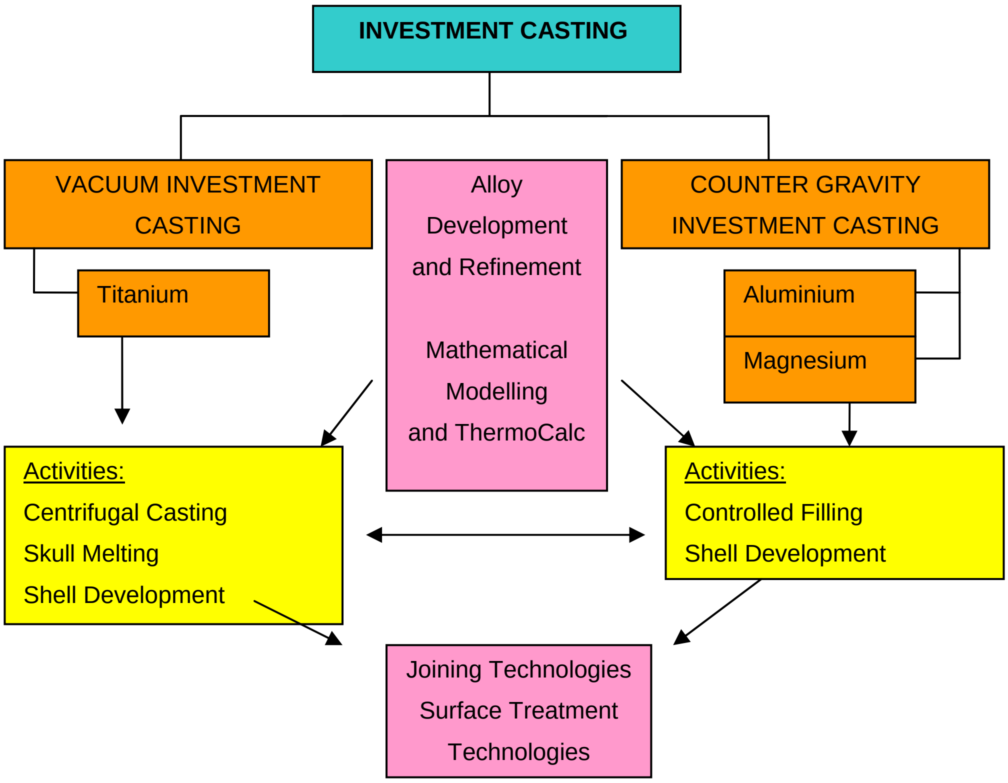
Project Overview and Objectives

The research areas that will form the basis for investment casting of light metal alloys are shown in the diagram below.

The main objective of this project is to establish the technology and its use for complex, near net-shape, high value components in South Africa. Specific applications will be the aerospace, automotive and electronics industries. In order to do this, the research will be focussed on:

- Developing and consolidating investment casting capability (short term)
- Alloy development and alloy refinement for specific applications (short & medium term)
- Process quality improvement and development to improve cost effectiveness (medium & long term)

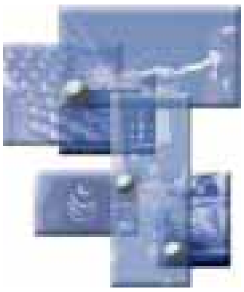
- Process application to produce complex, high value and thin walled components (short to long term)
- Component optimisation technologies (short to long term)



National Benefit and Global Impact

A national investment casting capability would be established to support and enhance our current industry. Having the capability in South Africa will assist industry to secure larger contracts due to the ability to produce more cost effective sub-components to the required quality standards. This capability would also open up new opportunities that do not exist currently as a result of current process constraints.

Diffusion of improvements in casting will be supported through a learning network and through newsletters, workshops and meetings. Strong relationships between industry and academia will facilitate uptake as the direction of the research and its outcomes will be guided to meet industry needs. The application of the advanced research and development programmes to major OEMs such as Airbus and Boeing, will also encourage stronger relationships between the AMTS and these stakeholders. It will allow a better understanding of our (SA's) abilities and their needs and will present future uptake and diffusion potential.



Hybrid Thermoplastic Composites

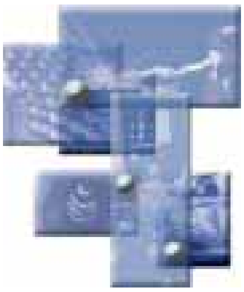
K Marcus and O Ofosu, University of Cape Town

This study in the area of thermoplastic (TP) and thermosetting (TS) composites is really aimed at doing a feasibility study of high performance TP and TS hybrid composites. Thermoplastics composites based on polyetheretherketone (PEEK) and polyetherimide (PEI) are now commonly used in the aircraft industry. These types of polymers have wide temperature range applications and good fire resistances. There is often interplay between toughness and strength or stiffness i.e. a stiffness decreases at the expense of an increase in toughness.

A considerable amount of work on these aspects has already been carried out using rubber modified polypropylene in our studies. Essentially the matrix is polypropylene and the secondary phase is a rubber (a copolymer of ethylene and propylene). This behaviour is similar for many polymer systems. Similarly, we have also experimented with other systems e.g. glass fibre filled nylon and talc filled polypropylenes. The engineering polymers are compounded with various filler levels in order to find an optimum balance in properties and the masterbatch can then be used for various applications in the aerospace and automobile industries. The other important aspect to note in these types of polymer composites, is the role of the interface and the balance of strength / toughness, depending on the interfacial shear strength. In this study we would first want to first identify what the property requirements are and then try optimise the composite in terms of filler concentration, size and distribution of the particulates (or fibres), and if compatibilisation is required. In order to do this, one needs access and spend time at the compounding facilities, to manufacture the test pieces, testing and improvement of properties.

We have had some success on hybrid composites where we developed a CFRP turbine blade for ABB Stal in Sweden. Our results indicate that one can improve the impact strength using Kevlar where a hybrid of carbon and Kevlar fibre (CFRP and KFRP) was found to perform adequately. The leading edges of the Airbus A380 are made from thermoplastic and so here they must have considered both impact (from larger particles) and erosion resistance. For thermoplastics the mechanical behaviour is sensitive to both strain rate and temperature and we have done some work down to -50^{o}C for PP copolymers. Normally there is a dramatic drop in impact strength at certain critical temperatures (close to the Tg) and this embrittling behaviour is obviously critical if the parts are going to be subjected to low temperatures. We have an instrumented drop weight tester to do these kinds of testing. The Airbus A380 has a considerable amount of CFRP and KFRP. The centre wing box is now entirely CFRP and offers substantial (~1500 kg) savings in weight.

What we have done is to study the how the properties of these composites change at different strain rates under tensile, compression and shear, from static to $10^{3}s^{-1}$. Very little data is available (at least in the open literature) on the mechanical data under very high strain rates in tension, shear and compression over three decades of strain. Other areas that are critical in this are fire smoke toxicity testing of both TP and TS, creep behaviour at various temperatures and fracture toughness studies. These need to be done in order to develop and possibly improve on existing structure and properties.



Natural Fibre Reinforced Composites

Rajesh Anandjiwala, CSIR

Consortium members:

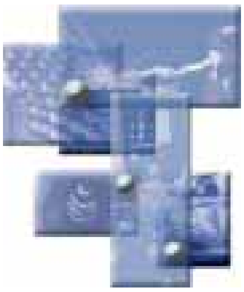
AMT Composites, PCISA, OEMs, Non-woven manufacturers, Wits, CSIR, TUT, (UCT, UKZN, to be Confirmed)

To develop natural fibre reinforced composites with competitive properties for automotive, Aerospace, Building and Packaging Industries. Thorough analysis of performance/properties required for the fibre reinforced composites for target applications. This includes the development of well separated flax fibres (both long and short) for compounding with polymer matrices.

Preparation of short-fibre nonwoven webs

Webs of different area density with different needle-punching and hydro-entangling parameters (optimised processing). Included is the fibre sizing, matrix silane and fibre surface evaluations via bond and cross-linking testing and microscopy.

Composites samples preparation by injection and RTM, testing of properties against required specifications. Full material characterisation for structural applications. Material failure evaluations. Fabrication of press moulding equipment. Organization of International Symposium on Natural Fibre Reinforced Composites in South Africa. Light weight automotive, aerospace and building applications parts.



Manufacturing Improvement

Robert Reid, University of the Witwatersrand

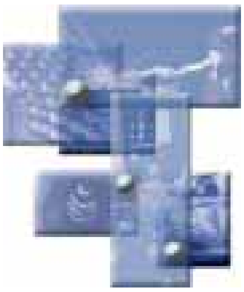
Consortium members

University of the Witwatersrand, Aerosud, BST, MMS, Epsilon, ATE, Aerodyne, Denel Aviation, Denel Optronics, UP, US, UCT

Introduction

The global aerospace industry is becoming increasingly competitive and as such there is continuing pressure on quality, delivery and cost. There is acceptance within the South African industry that while business processes within individual companies can probably be improved and hence the competitiveness of the industry as a whole can be improved, it is not currently known where these deficiencies lie.

This project seeks to benchmark the business processes of the local industry (starting with the composite component suppliers) so that individual companies know where they stand relative to their peers and also against international norms. Appropriate intervention-type student projects will then be designed and implemented (with full participation of the industrial participants) to raise the competitiveness of the industry. It is important to emphasize that this project works via two routes; directly by remedying deficiencies within individual companies, and also more sustainably through the supply of appropriately skilled professionals with experience gained in the industry through participation in this project.



Development of Smart Composite Materials with Strain Sensing Capability

Victor Verijenko, University of KwaZulu Natal

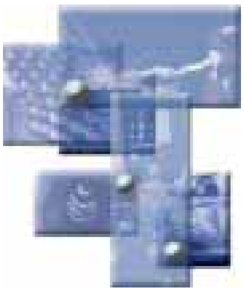
The majority of load bearing structural components used in different areas of engineering require periodic inspections of their integrity and assessment of accumulated in-service damage as part of their safety and maintenance requirements. Both costly in monetary terms and down time, these operations could be replaced by a new genre of inspection techniques called automated structural health monitoring. This new technology requires the placement of sensors in the structure permanently that can be interrogated periodically or as the need arises. One class of the materials that allows incorporation of sensors within the material is fibre reinforced composites. However, the development of "smart" composite materials/structures which can monitor their own structural "health" represents an important and technologically challenging problem.

The proposed effort is to employ three different sensor techniques within fibre composites, i.e. based on fine wires made of "strain memory" alloy that can be woven directly into composites and that can be used as peak strain sensors (locally developed technology), based on fibre optics embedded within the material and based on application of piezo-electric sensors. The ultimate goal is to develop a smart composite material that can be utilized in load bearing composite structures with a view towards low-cost, straightforward methodology for damage detection in this type of structures.

Other objectives of this project are given as follows:

- To create within the technological expertise pool, a group of South African scientists and engineers capable of designing and manufacturing new material systems as well as systems in the field of structural health monitoring. This would include not only established researchers with proven track records, but also new scientists (including those from emerging groups) who will contribute to the country's future technological advancement.
- To exploit the unique situation within South African industry, which allows cost-effective production of small to medium batches of materials for specialized niche market component production.
- To encourage collaboration among industry, small business, technical institutions, universities and research organizations.
- To promote South Africa as a centre for high-quality research and niche market manufacturing.

The project is anticipated to be completed within 3 years. Current consortium consists of the following organizations: UKZN (lead organization), Incomar, ATE, USB, UP.



Continuous Fibre Reinforced Thermoplastics Processing Development

Johan Steyn, AeroSud

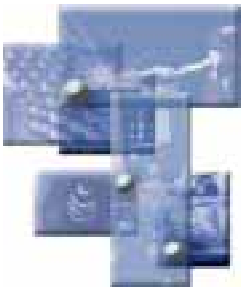
Stakeholders

Aerosud Interiors, AMT, Epsilon, Aerodyne (AAT), US, UCT, Wits, UP, CSIR

Synopsis

- Material and Tooling Technology Identification: Lead organization to be AMT, and activity to be completed in the first quarter of the year, to facilitate the implementation of knowledge/information in the selected developments.
- Demonstrate the feasibility of manufacturing a load bearing aviation seat structure from CFRTP materials: Lead organization to be US (AAT, UCT), and will focus on the design, analysis and test of an aviation seat structure.
- Demonstrate and explore the generic manufacturing parameters of a selection of CFRTP materials, coupled to low cost tooling solutions: Lead organization to be Aerosud (Epsilon, WITS, UP, CSIR), and will focus on processing parameter identification and application using a generic design and tooling options.

The nature of the two technical investigations are rather different in approach and outcome, and therefore it is suggested that two teams are formed, "South team" and "North team", but with regular interaction and exchange of learning. The balance of analytical approach (with strong university participation), and manufacturing process development (with strong industrial participation) is regarded as the best pragmatic approach for the first year of this program. Based on the outcomes and lessons learned, the focus may have to be adjusted for 2007 onwards.



UAVs as a Vehicle for Technology

John Wesley, CSIR

Industry can only apply technology in product development once it has reached a sufficient level of maturity and has achieved a demonstrated a validated level of technology readiness. This validation process normally consist of demonstrations at various levels of maturity ranging from proof of concept in a laboratory or simulated environment through to advanced demonstrators at a systems level in an operational environment. Relatively small UAVs offer a cost effective way of demonstrating technologies developed in both of the AN flagship programmes (advanced materials and advanced avionics) and can serve as a focus for the developers of aerospace technologies supported by the AMTS like nanotechnology sensors, highly integrated electronics and advanced high speed data processing. On the other hand an emerging area of interest is the development of a persistent surveillance capability based on stratospheric airships. Here the sensor technologies tend to merge with space based sensor technologies and offer a platform that is more accessible than space for the demonstration of systems at the higher levels of technology readiness.