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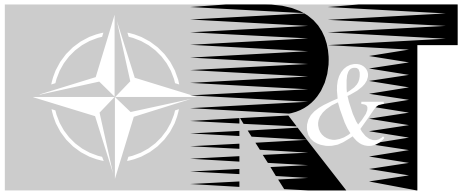

RESEARCH AND TECHNOLOGY ORGANISATION

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RTO MEETING PROCEEDINGS 69(II)

Low Cost Composite Structures

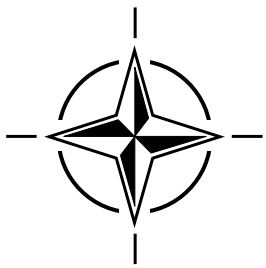
(Les structures composites à bas coût)

and

Cost Effective Application of Titanium Alloys in Military Platforms

(La mise en œuvre rentable des alliages de titane dans les plates-formes militaires)

Papers presented at the RTO Applied Vehicle Technology Panel (AVT) Specialists' Meeting held in Loen, Norway, 7-11 May 2001.



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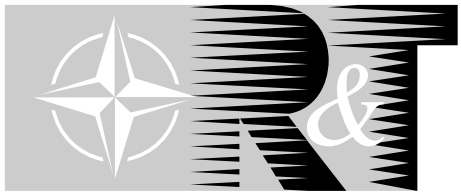

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The Research and Technology Organisation (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote cooperative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective coordination with other NATO bodies involved in R&T activities.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also coordinates RTO's cooperation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of initial cooperation.

The total spectrum of R&T activities is covered by the following 7 bodies:

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS Studies, Analysis and Simulation Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

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Low Cost Composite Structures

(RTO MP-069(II) / AVT-076)

Executive Summary

The development of military systems that utilise composite materials for their structures has continued to increase, but one of the factors which still limits their applicability is their cost, compared to metallic systems. Composites have demonstrated in both the land, sea and air environments that their use can substantially reduce the weight and consequently increase the performance of military equipment. Composite may also offer maintenance cost reduction due to their better corrosion and fatigue properties. But, as defence budgets continue to decline in real terms, the cost of new equipment is becoming increasingly important, to the detriment of potentially increased capability.

The objective of this Specialists' Meeting was to explore the recent advances in the design and manufacture composite structures for military systems to identify both common themes and unique differences between the services and how each in addressing the requirement for reduced cost.

The drawing together of representatives from all three environments (air, sea and land) was a rather unique feature of the meeting, which contributed to both the high levels of interest of the papers and exchange of ideas during the discussions.

A total of 21 papers were presented with authors representing 11 member countries. It was felt by many of attendees of the meeting that the meeting's emphasis on products and lessons learnt from producing hardware, rather than pure scientific research, was one of the key factors that contributed to the success of the meeting.

Les structures composites à bas coût

(RTO MP-069(II) / AVT-076)

Synthèse

Le développement des systèmes militaires utilisant les structures composites a continué à croître, mais un des facteurs qui limite toujours leur application est leur coût, comparé aux systèmes métalliques. Les composites ont démontré dans les environnements terrestres, marins et aériens que leur utilisation peut réduire substantiellement les poids et en conséquence accroître les performances des équipements militaires. Les composites peuvent aussi apporter des réductions de coûts de maintenance par leur meilleure tenue en corrosion et en fatigue. Mais comme les budgets de défense continuent à décroître en termes réels, le coût des équipements nouveaux devient de plus en plus le point important, au détriment de l'accroissement possible des capacités.

L'objectif de cette réunion des spécialistes était d'explorer les progrès récents dans la conception et la fabrication de structures composites pour les systèmes militaires, pour identifier à la fois les thèmes communs et les différences uniques entre les services et la façon dont chacun aborde l'exigence de coûts réduits.

La réunion de représentants des trois environnements (air, mer et terre) était une caractéristique plutôt unique de ce meeting, qui a contribué à la fois au haut niveau d'intérêt des présentations et des échanges d'idées pendant les discussions.

Un total de 21 papiers a été présenté par des auteurs représentant 11 pays membres. Il a été ressenti par beaucoup des participants de ce meeting que l'orientation vers les produits et l'expérience acquise en produisant les structures, plus que vers la pure recherche scientifique, était un des facteurs clé qui ont contribué au succès de ce meeting.

Cost Effective Application of Titanium Alloys in Military Platforms

(RTO MP-069(II) / AVT-077)

Executive Summary

Titanium alloys offer major weight and performance benefits for military platforms due to their combination of lightweight, corrosion resistance and high temperature capabilities. The meeting provided a successful forum for information exchange and discussions by specialists on the cost-effective application of titanium alloys to air, land and sea platforms. While the development of titanium alloys and processing technology, such as casting, superplastic forming and diffusion bonding, is relatively mature, the application of titanium and its alloys in military systems depends on several factors, the primary one being cost.

Twenty presentations from 9 countries discussed titanium extraction, casting technology, component fabrication, use for ballistic protection, and applications in platform subsystems. The attendees concluded that reducing costs associated with the insertion of titanium and its alloys into military systems requires that all aspects of processing, design and manufacturing are addressed. Modeling can have a significant impact on total cost, starting with that associated with reducing defects in castings, through to finite element modeling of processing, e.g. extrusion and forging. Modeling of microstructure/property relationship also reduces the number of tests required for qualification of new materials and allows more accurate life predictions. Advanced computational and manufacturing technologies and development of methods for assessing properties from a design confidence point of view can reduce costs and increase the usage of titanium and its alloys in military systems.

The application of new processing and design technologies is expected to reduce the cost of titanium component significantly. This will lead to far wider application of titanium alloys in military systems and the military operator will benefit from increased performance with through life cost savings relative to more traditional metallic structures.

La mise en œuvre rentable des alliages de titane dans les plates-formes militaires

(RTO MP-069(II) / AVT-077)

Synthèse

Les alliages de titane offrent des avantages majeurs de poids et de performances pour les plates-formes militaires dus à la combinaison de leurs caractéristiques de légèreté, de résistance à la corrosion et de haute résistance à chaud. La réunion fut l'occasion d'un forum réussi pour des échanges d'information et des discussions entre spécialistes au sujet de l'utilisation rentable d'alliages de titane dans des plates-formes terrestres, aériennes et maritimes. Alors que le développement des alliages de titane et des technologies de transformation comme le coulage, le formage superplastique et l'assemblage par diffusion, est relativement mature, l'utilisation du titane et de ses alliages dans les systèmes militaires dépend de plusieurs facteurs, principalement le coût.

Vingt présentations faites par 9 pays ont traité de l'extraction du titane de la technologie du coulage, de la fabrication des composants, de l'utilisation pour la protection balistique, et des applications aux sous-systèmes de plate-forme. Les participants ont conclu que la réduction des coûts associée à l'insertion du titane et de ses alliages dans les systèmes militaires nécessite que tous les aspects de la transformation, de la conception et de la fabrication soient abordés. La modélisation peut avoir un impact important sur le coût total, en commençant par la réduction des défauts dans les pièces coulées, en passant par la modélisation par éléments finis du procédé de transformation, par exemple l'extrusion et le forgeage. La modélisation de la relation microstructure/propriétés réduit aussi le nombre d'essais nécessaires pour la qualification des nouveaux matériaux et permet des prévisions plus précises. Les technologies de fabrication et d'informatique avancées et le développement des méthodes d'évaluation des propriétés du point de vue de la fiabilité de conception peuvent réduire les coûts et augmenter l'utilisation du titane et de ses alliages dans les systèmes militaires.

On peut s'attendre à ce que l'utilisation de nouvelles technologies de conception et de transformation réduise le coût des pièces en titane de façon importante. Ceci permettra une utilisation plus large des alliages de titane dans les systèmes militaires et l'exploitant militaire bénéficiera d'une augmentation des performances associée à des économies sur le coût du cycle de vie par rapport aux structures métalliques plus traditionnelles.

Click inside the blue boxes or on the titles to view the corresponding section

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SESSION II: COMPONENT FABRICATION PROCESSES

† Paper not available at time of production.

SESSION III: TITANIUM ALLOYS FOR BALLISTIC PROTECTION

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SESSION V: TITANIUM APLICATIONS IN PLATFORM SUBSYSTEMS

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MEETING PROCEEDINGS (MP)

Reduction of Military Vehicle Acquisition Time and Cost through Advanced Modelling and Virtual Simulation
MP-089, March 2003

Advanced Flow Management: Symposium Part A – Vortex Flows and High Angle of Attack for Military Vehicles / Part B – Heat Transfer and Cooling in Propulsion and Power Systems
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Low Cost Composite Structures / Cost Effective Application of Titanium Alloys in Military Platforms
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Ageing Mechanisms and Control: Specialists' Meeting on Life Management Techniques for Ageing Air Vehicles
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Active Control of Engine Dynamics
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Planar Optical Measurements Methods for Gas Turbine Engine Life
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High Order Methods for Computational Physics, Published jointly with Springer-Verlag, Germany
EN-5, March 1999

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Ice Accretion Simulation Evaluation Test
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Verification and Validation Data for Computational Unsteady Aerodynamics
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Recommended Practices for Monitoring Gas Turbine Engine Life Consumption
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A Feasibility Study of Collaborative Multi-facility Windtunnel Testing for CFD Validation
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Application in military systems	Electron beam processing	Marine vehicles	Processing
Assessing design confidence	Extrusion	Mechanical properties	Qualification
Ballistic protection	Fabrication	Microstructure	Reduce
Casting	Finite element analysis	Microstructure/property relationship	Reduced life cycle costs
Casting technology	Finite element modelling	Military air platforms	Simulation
Component fabrication	Forging	Military land platforms	Subsystems
Composite materials	Fuselages	Military sea platforms	Superplastic forming
Composite structures	Helicopters	Military vehicles	Testing
Corrosion resistance	High performance composites	Modelling	Textiles
Cost	High temperature capabilities	Modelling techniques	Titanium alloys
Cost analysis	Land vehicles	Models	Titanium component
Cost-effective	Life predictions	Performance	Titanium extraction
Defects in castings	Lightweight		Weight
Design	Low cost composites		

14. Abstract

The meeting on Low Cost Composite Structures analysed the possibilities to make the use of composite materials for structures of military systems affordable. Composites are still more costly than metallic systems but they have advantages reducing the weight and consequently increasing the performance of military equipment. This included also the replacement of metallic part by composites in existing vehicles. They may also reduce maintenance cost due to their better corrosion and fatigue properties. The meeting explored recent advances in the design and manufacture of composite structures for military systems for air, sea and land vehicles. 21 papers from 11 member countries were presented and the meeting was introduced by a keynote on Cost Effective Use of Materials from Design to Disposal of Military Systems.

The meeting on Cost Effective Application of Titanium Alloys in Military Platforms analysed major weight and performance benefits for military air, land and sea platforms due to their combination of lightweight, corrosion resistance and high temperature capabilities. Given mature processing of titanium alloys such as casting, superplastic forming and diffusion bonding, the application in military systems depends on several factors, the primary one being cost. Twenty presentations from 9 countries discussed titanium extraction, casting technology, component fabrication, use for ballistic protection, and applications in platform subsystems. Reducing costs of using titanium and its alloys in military systems depends on processing, design and manufacturing factors. Modelling can significantly contribute to better processing (reducing defects in castings, finite element modelling of processing, e.g. extrusion and forging) and to reducing testing and qualification (microstructure/property relationship, qualification of new materials, life predictions, assessing properties from a design confidence point of view). Application of new processing and design technologies is expected to reduce the cost of titanium component significantly, yielding increased performance and reduced life cycle costs.

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