



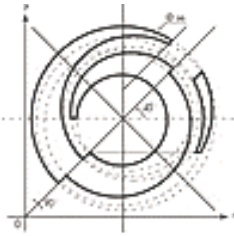
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CINDERS

ENK5-CT2000-00068

Michael Henderson - Project Co-ordinator

ALSTOM



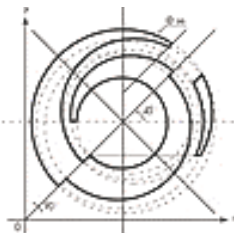
Project Overview



CMC Integration and Demonstration for Gas Turbine Engines

Objectives

- develop and demonstrate thermal/environmental protection of CMC combustion chamber
- develop application methods for thermal protection system (TPS)
- develop NDE methods for CMC and CMC/TPS systems
- develop design, stress analysis and life prediction tools for CMC and CMC/TPS systems



Commercial CMCs

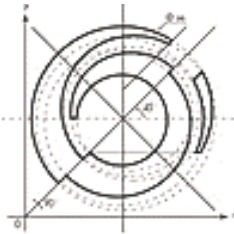
Advantages

- High temperature capability
- High strength
- High toughness
- Low density
- Tailored properties

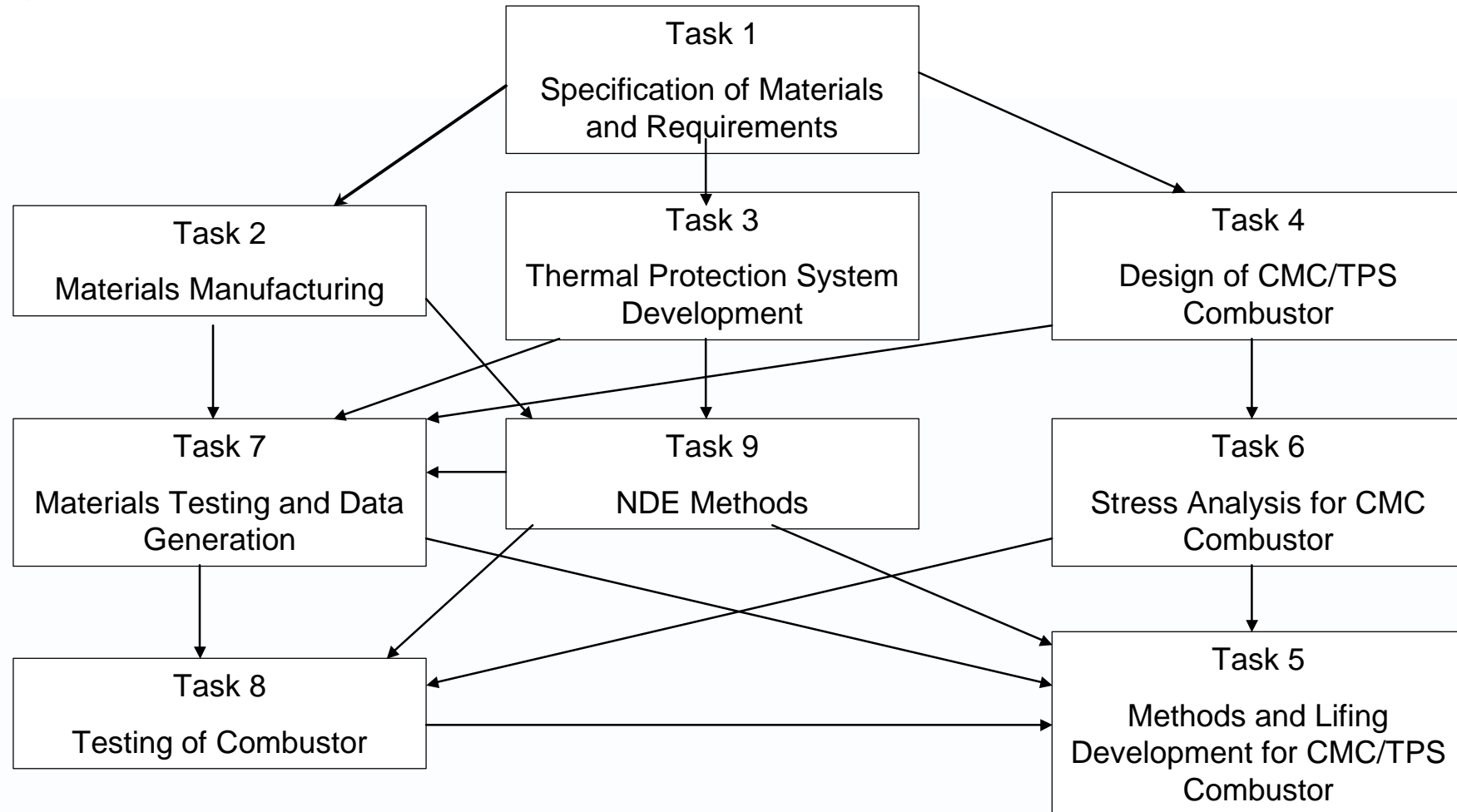
Disadvantages

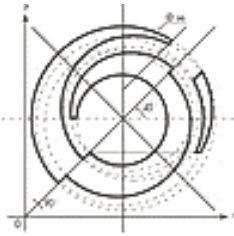
- Matrix strength
- Interface materials (C,BN)
- Cost





Project Overview



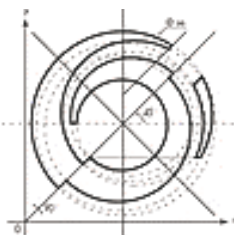


Project Partnership



-  **ALSTOM Power - Co-ordinator**
 - materials evaluation, TPS development, stress analysis, lifing, database
-  **Rolls-Royce plc (UK)**
 - materials evaluation, TPS development, stress analysis, lifing, database
-  **Nuovo Pignone (Italy)**
 - component design and testing
-  **Turbomeca (France)**
 - design and stress analysis, sub-element and oxidation/corrosion testing
-  **SNECMA-SEP (France)**
 - materials supply: samples, sub-elements and components, design
-  **Ansaldo (Italy)**
 - materials evaluation, lifing



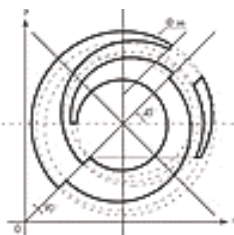


Project Partnership



- ✍ **Flame Spray (Italy)**
 - Development of thermally sprayed TPS
- ✍ **ONERA (France)**
 - Development of sol-gel TPS
- ✍ **UMIST (UK)**
 - Development of sol-gel TPS
- ✍ **RIF (Germany)**
 - NDE for thermally sprayed TPS
- ✍ **EMPA (Switzerland)**
 - NDE for sol-gel TPS

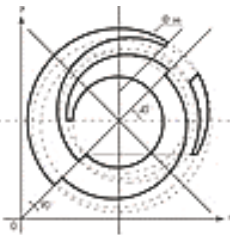




Materials Supply/Testing:

- ✍ **Batch 1 Cerasep G415 panels manufactured**
 - 10 off: 3 for spray deposition testing, 7 for mech. test
 - panel cut-up and seal coat application in progress

- ✍ **Problems encountered with delivery of MI SiC/SiC HiNicalon fibre composite (low UTS properties)**
 - alternatives offered not commercial products
 - stay with HiNicalon fibre product (set time limit for delivery)
 - oxide-oxide system in place as fallback option



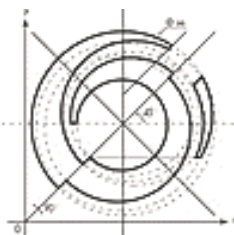
Materials Supply/Testing:

✎ Batch 1 A/N720-1 oxide-oxide composite

- testing and characterisation
- LCF, creep, tensile behaviour
- thermal shock, thermal exposure

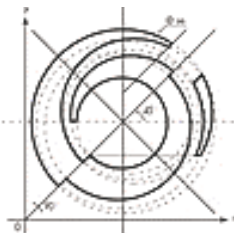
✎ Initial Conclusions:

- excellent LCF properties at temperature upto 1100°C
- material limited by creep
- thermal ageing does not appear to affect the material



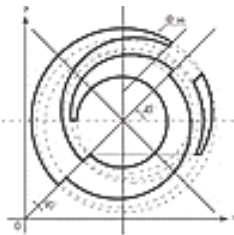
TPS coating assessments on-going:

- physical property evaluation of alumina, zirconia, mullite candidates (Flamespray, ONERA)
- thermal spray deposition trials and characterisation (Flamespray)
- refinement of sol gel deposition process and characterisation (ONERA, UMIST)
- sintering behaviour, thermal stability (ONERA)
- X-Ray NDE techniques evaluated for inspection and modelling composite structures (RIF)



Deliverables:

- ✍ Consortium Agreement issued for signatures
- ✍ Six month report issued
- ✍ Definition of test matrices for Cerasep 415 and COI materials (MI test definition delayed)



Key Future Actions

- ✍ Development of 2nd Generation TPS.
 - ✍ Development of material compositions suitable for thermal protection (for Sol-Gel and Thermally sprayed coating techniques).

- ✍ Development of Application Techniques.
 - ✍ Development of suitable application techniques for developed TPS's.

- ✍ Development of Lifting Techniques for Ceramic Matrix Composites.
 - ✍ Completion of computer simulation models to predict component behavior both with and without thermal protection

The image features the Alstom logo centered on a white background. The logo consists of the word "ALSTOM" in a bold, sans-serif font. The letters "A", "L", "S", "T", and "M" are dark blue, while the letter "O" is red and stylized with three concentric, slightly offset circles. Above the logo, a large, curved graphic element spans across the top. It is composed of a thick red band that curves downwards from the left, and a blue band that curves downwards from the right, meeting the red band in the center. The background behind the blue band is a gradient of blue and purple.

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