Introduction

ADS trade organisation

The premier trade organisation advancing UK Aviation, Defence, Security and Space Industries globally

- Serves over 900 UK based member companies (2300 with regional partners)
  - Manufacturers
  - Suppliers
  - Service companies
  - Operators
  - Small start ups
  - SME
  - Large global organisations

- Represents the industry in all issues that affect ADS industry sectors, from environment and sustainability to supporting innovation and growth for SMEs
Material Challenges for Aerospace

Operational environment of aerospace products

- Very arduous design requirements
  - Safety is paramount
  - Product life cycle is very long
  - Weight = Cost

- Operational environment is also extremely severe

- This results in a very limited range of material options for a given level of performance

- Understanding material supply risks is therefore a very important element of long term material planning
Material Challenges for Aerospace

Material criticality

- Material supply risk is based on two elements of criticality
  - Likelihood of a supply disruption
  - Impact on the business

- Assessment of business impact is well establish, but likelihood is a multifaceted problem made up of:
  - Physical factors
  - Market factors
  - Political factors

- There are therefore many things that can have a significant affect on the supply of materials
Material Challenges for Aerospace

Example 1 – Turbine blade alloys

- The microstructure of nickel base, single crystal, superalloys is made up of a high volume fraction of intermetallic $\gamma'$ particles uniformly distributed in a ductile metallic $\gamma$ matrix.

- The ordered crystal structure of the $\gamma'$ phase is inherently more resistant to deformation than the random distribution of elements in the disordered $\gamma$ lattice.

- To enhance the mechanical properties, nickel base superalloys are heavily alloyed to strengthen the $\gamma$ phase and optimise the $\gamma'$ volume fraction to make deformation as difficult as possible.
Material Challenges for Aerospace

Example 1 – Turbine blade alloys

The graph illustrates the composition changes of turbine blade alloys over different generations from 1955 to 2005. The composition of key elements such as Cr, Co, Mo, Ti, Ta+W, Al, Re, and Ru is shown for Conventionally Cast and Generation SX alloys. The data indicates a trend towards increased alloying of elements like Ta+W and decreased content of Cr and Co as technology advanced.
Material Challenges for Aerospace
Example 1 – Turbine blade alloys

• Due to the high performance demands, we have little choice but to keep using these alloys in the short to medium term

• The potential supply risks necessitate a range of mitigative responses

  • **Short- medium term**: Secure supply, enhance resource efficiency, enhance reclamation
  
  • **Long term**: develop new alloys, develop new design methodologies
Material Challenges for Aerospace

Example 2 – Corrosion protection

• Aircraft gas turbine engines are exposed to some highly corrosive contaminants

• Some parts of the engine require extra corrosion protection to maintain the high safety standards

• At present, the only process that meets the rigorous standards for aerospace is chrome coating, which requires hexavalent chrome
Material Challenges for Aerospace

Example 2 – Corrosion protection

- Hexavalent chrome is a genotoxic carcinogen and is on the REACH candidate list for authorisation (no sunset date yet – but there will be one soon)

- In this instance, the problem material is not embodied within the product, but is necessary to operate the process

- Due to the legislative restrictions placed on this material, our only option is to substitute the process or material

- The challenge is:
  - The industry won’t ‘daisy chain’ to an equally toxic substance
  - The industry will not accept a lower level of performance

- The most viable solution is to find another way of getting the chrome on to the component surface
Material Challenges for Aerospace

Conclusions

• The aerospace industry has very stringent material requirements, which limits the options available when specifying solutions.

• Understanding the factors that affect the long term supply of these materials is critical to defining the appropriate responses.

• There are a range of material supply issues that are being managed by the industry. More will follow.