

Breakout Questions: Day 1- Group B - Aerospace

- ▶ Temperature Target: ARPA-E aims to develop technologies that would bring a step-change to the field. Is the target of **200C** increase over the SOA high temperature materials a plausible goal?
- ▶ What are the likely material systems that should be in the scope to achieve this optimistic target?
 - Comment on refractory metal alloys (Nb, Mo..), RHEA, Ceramics and CMCs
 - Discuss current state, limitations and opportunities
- ▶ What should be the specific technical metrics in terms of mechanical properties that a new material must meet at a given temperature?
- ▶ What would be the technical & commercial impact of ultrahigh temperature material that can be used at temperatures >200 C higher than the SOA material?
- ▶ How much does material cost matter? If efficiency was increased by 5%, but the material were 3X as expensive, would you still consider it? What other features could tip the scales?
- ▶ At what new level of efficiency would early retirement of existing fleets become a very real possibility?

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Property	Refractory Alloys	RHEA	Ceramics	CMC
Oxidation resistance				
High temperature strength				
Creep resistance				
Fracture toughness				
Fatigue resistance				
Manufacturability				
Cost				
Reliability				
Repair ability				
Overall potential				
Other				

Rating Criteria:

1. Worse
2. Bad
3. Same
4. Better
5. Best

- Use existing Ni-base superalloys as a benchmark
- Discuss in relation to turbine blade application

Supplementary slide if needed for discussion for Q#2

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Property	Alloys	Current State	FOA Target
Tensile Yield Strength (MPa)	Udimet 500	730 MPa (760C)	750-1000 MPa (1000°C)?
	CMSX-10	994 MPa (760C)	
	Udimet 700	830 MPa (760C)	
	DS Mar M200+Hf	925 MPa (760C)	
Creep Rupture Strength (100 h)	Udimet 500	305 MPa (810C)	300-450 MPa (1000C)?
	Udimet 700	400 MPa (810C)	
	DS Mar M200+Hf	465 MPa (810C)	
Fracture Toughness (MPa-m ^{1/2})	Ni-based Matls.	90-100	90-100 @T?
Liquidus (C)	Ni-based Matls.	1250-1350	>1500?
Oxidation Res. (x 10 ⁻⁶ mg ² . cm ⁻⁴ .s ⁻¹)	Inconel 718	40 (1100C)	?
Hot Corrosion Resistance	Ni-based Matls.	Good	?
Thermal Conductivity			?
Thermal Expansion Coefficient (10 ⁻⁶ K ⁻¹)	Udimet 700	16-18 (20-800C)	?
	Udimet 500	13.3 (20-100C)	
	Inconel 718	16.0 (20-760C)	