Advanced Materials & Battery Technologies for a Sustainable Future

M-ERA.NET Call 2021 success stories: enabling innovation through collaborative projects
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AM-ACTS

Additive Manufacturing of Actively Cooled Thermal Shields

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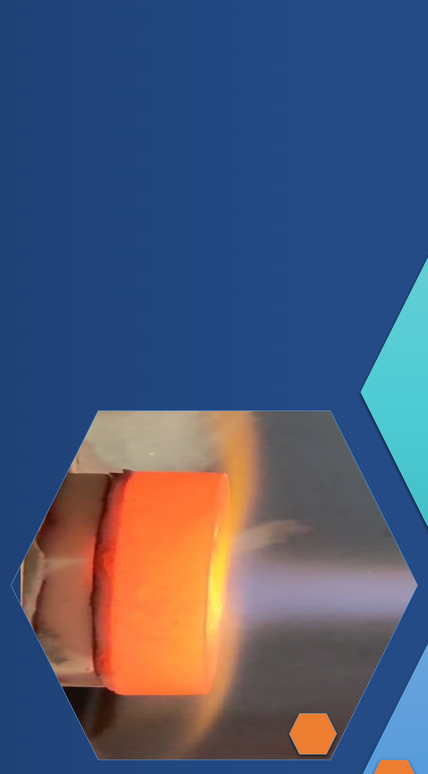
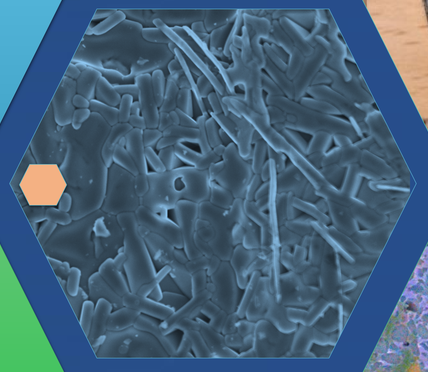
PROJECT IMPACT

- AM-ACTS project has provided a **proof-of-concept** of novel high-performance **thermal shield elements actively cooled** through **bioinspired internal microchannels** created by **additive manufacturing** (AM).
- AM and low-energy sintering processes produced **actively cooled thermal shields (ACTS) from ultra-high temperature ceramics (UHTCs) and refractory metals:**
  - **Reliable UHTCs** (ZrB_2, TiB_2, ZrC) **feedstocks** for Direct ink writing (DIW), with and without **BN reinforcing platelets**.
  - **Inconel 718/ZrB_2** bonding and **multi-material constructs** and **functionally graded materials** (FGM) have also been **explored experimentally and numerically**.
- **Solutions for** the sustainable production of **thermal shields** for atmospheric re-entry in **reusable** spacecrafts, turbine blades, rocket engines, reactor walls or solar receivers **with improved maximum service temperature and/or service lifetime** at a given temperature.



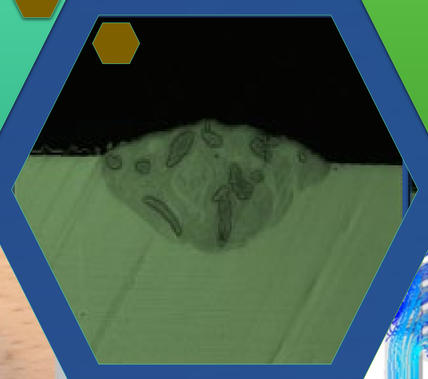
DIW of UHTC ceramics (ZrB_2, ZrC, TiB_2) ACTS microchanneled parts

AM Ultra-high temperature ceramics reinforced with BN platelets

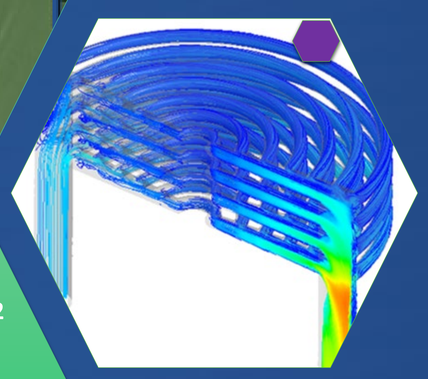


Metal-based ACTS produced by DED

Metal/ceramic joining through DED

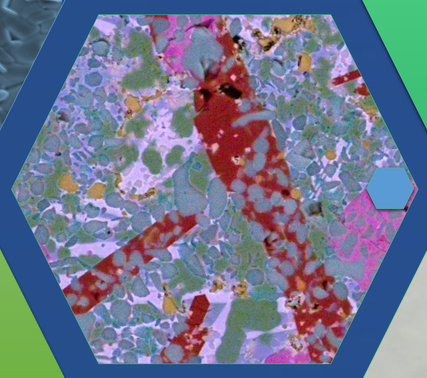


ACTS channel design and optimization by CFD and FEM



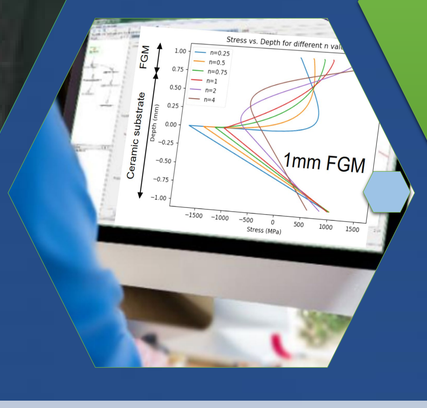
UHTC and UHTC/Inconel ACTS materials thermal testing in flame furnace

Inconel 718 /ZrB_2 composites and functionally graded materials (FGM) developed



DLP and freeze casting combined to produce ACTS from UHTCs

UHTC, Inconel ACTS solar thermal tests in dissociated O



Computationally designed FGM strategy to minimize stresses

OBJECTIVES ATTAINED

- AM-ACTS solutions address the insufficient thermal protection provided against most aggressive environments by passive TPS.
- Active cooling reduces significantly the temperatures the TPS material needs to withstand which leads to increased durability by reducing failure due to poor oxidation resistance and ablative wear.
- Multimaterial ceramic/metal combinations and platelet reinforcement address the intrinsic brittleness of UHTCs increasing their lifetime under service conditions.

ACKNOWLEDGMENTS

M-ERA.NET

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