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R&D

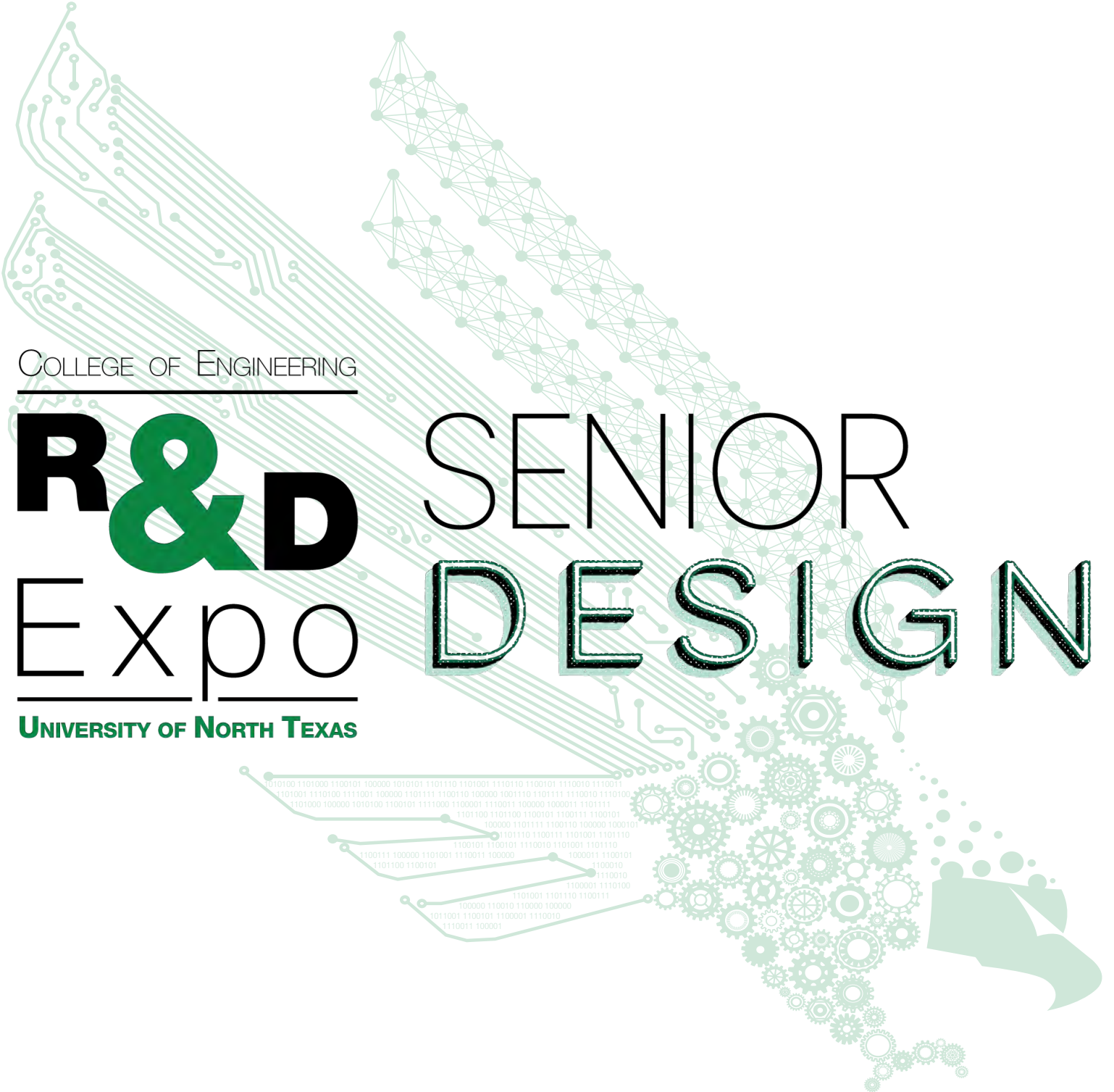
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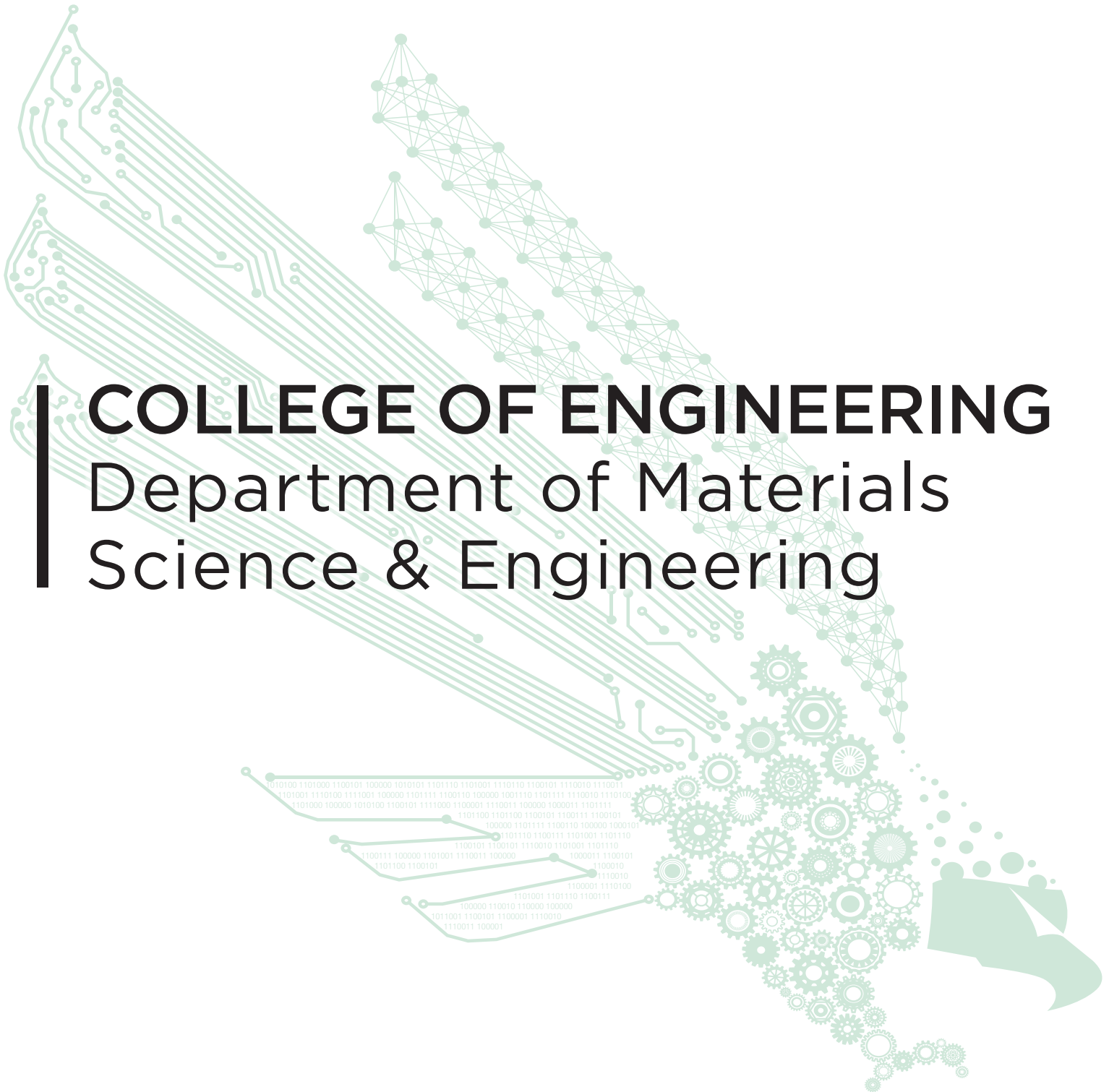
UNIVERSITY OF NORTH TEXAS

SENIOR

DESIGN

Spring 2026





COLLEGE OF ENGINEERING

Department of Materials
Science & Engineering

**Senior Design Abstracts
Spring 2026**



Copper-Based Shape Memory Alloys for Elastocaloric Cooling

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External Sponsors/Mentors

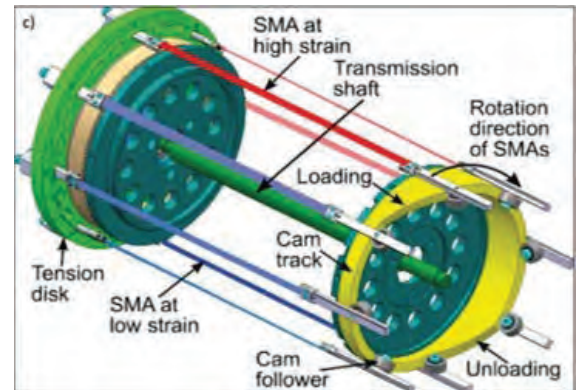
Consortium for the Advancement of Shape Memory Alloy Research and Technology (CASMAART)
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Internal Sponsors/Mentors

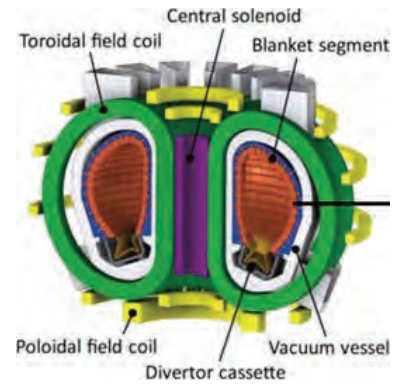
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Abstract

Current cooling systems rely on vapor-compression cycles that use refrigerant gases such as hydrofluorocarbons (HFCs), which have global warming potentials up to 10,000 times greater than CO₂. Solid state cooling based on elastocaloric shape memory alloys (SMAs) offer a promising solution with maximization of cooling efficiency and minimization of energy consumption. Cu-based SMAs designed for elastocaloric cooling possess microstructures consisting of large grain sizes and triple junctions resulting in embrittlement, fatigue cracking, and mechanical failure. CuAlNiTi and CuAlZn have been identified as promising base alloys for elastocaloric devices. In this study, we have selected the following two compositions for investigation: (Cu-29Al-4Ni-1Ti)100-xBx (at%) where x=0,1 and Cu-16Al-16Zn (at%). Two strategies for microstructural improvements were explored: cold working and microstructural processing of (Cu-29Al-4Ni-1Ti)100-xBx to produce ultrafine-grained structure and heat treatments of Cu-16Al-16Zn to create an oligocrystal structure, an ultracoarse-grained structure. Results from both approaches showed improved elastocaloric performance through engineered microstructural pathways.



Designing Functionally Graded Alloys (FGAs) for Nuclear Fusion Device Applications



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Abstract

The innermost plasma-facing components (PFCs) and outer structural components (SCs) supporting nuclear fusion devices experience vastly different operating conditions. Resulting differences in properties such as the coefficient of thermal expansion (CTE) make PFC-SC joints difficult to process and prone to failure during thermal cycling. Functionally graded alloys (FGAs) are a promising method to address these joining issues by gradually varying selected properties (e.g. CTE) across a volume. In this work, a CTE-graded FGA between W and V (leading PFC and SC candidates respectively) was designed and fabricated through a one-step spark plasma sintering approach. Structure-properties-performance relationships for the designed FGA were examined through electron microscopy, x-ray diffraction, density measurements, and hardness tests. Preliminary results suggest that even heterogeneous interlayers can still improve the integrity of PFC-SC joints.



The team is grateful for the continuous support and guidance of our faculty advisors, mentors, and professors.



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