Karlsruhe Institute of Technology

Institute for Applied Materials

Development and application of a high-temperature micromechanics stage with a novel temperature measurement approach

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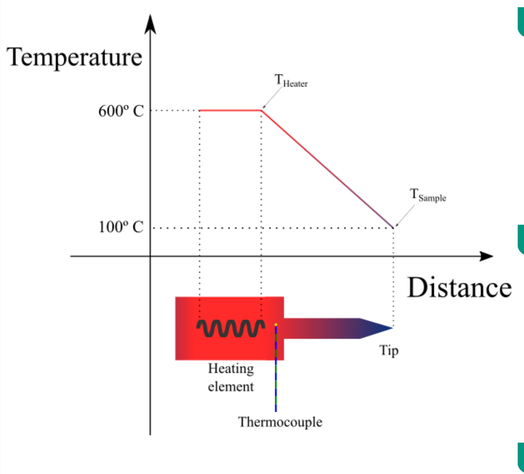
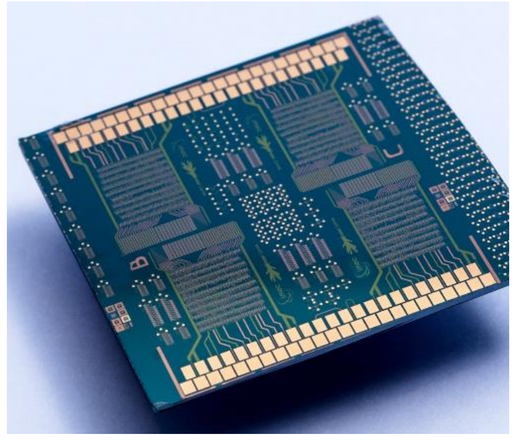
Motivation and Introduction



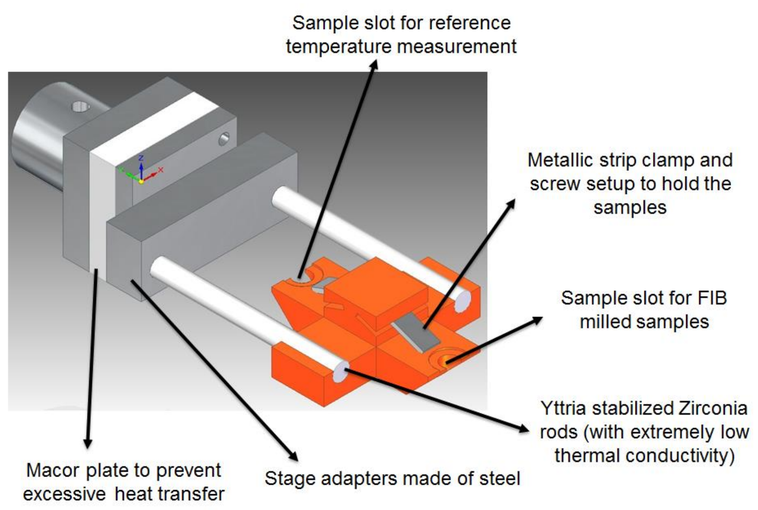
Current temperature measurement protocols

- Despite the advances in the instrumentation of HT micromechanics setups over the last decade, an improvement in the contact temperature measurement is still required to eliminate the inaccuracies in currently available commercial systems.
- Copper alloy thin film systems, well accepted candidates at room temperatures for metallization components in electronic circuit systems can behave differently at their service temperatures with respect to their strength retention capabilities.
- A novel micromechanical testing design [1] with independent tip and sample heating is developed to characterize Cu-Ag and Cu-Zr systems at high temperatures.

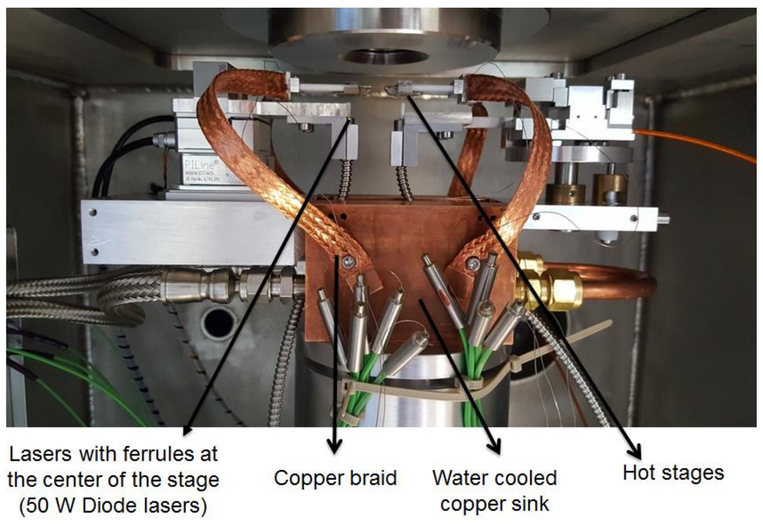


Copper metallization in electronic circuits

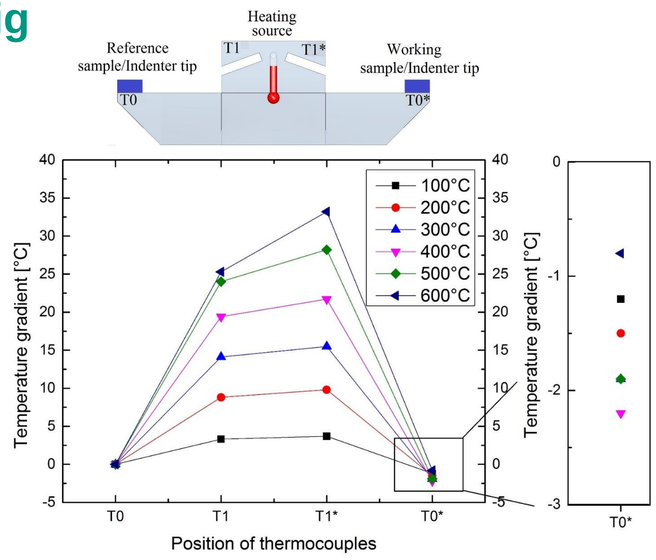
Novel design and accuracy of the straining rig



Hot stage design

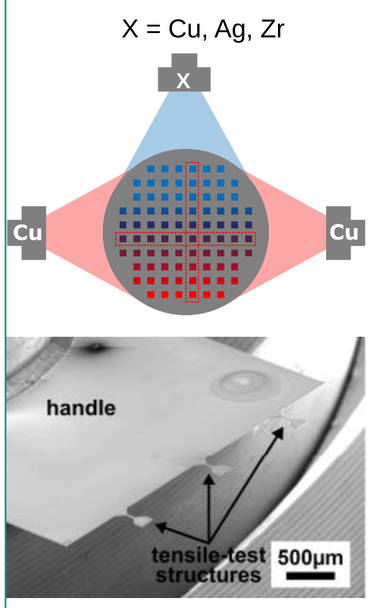


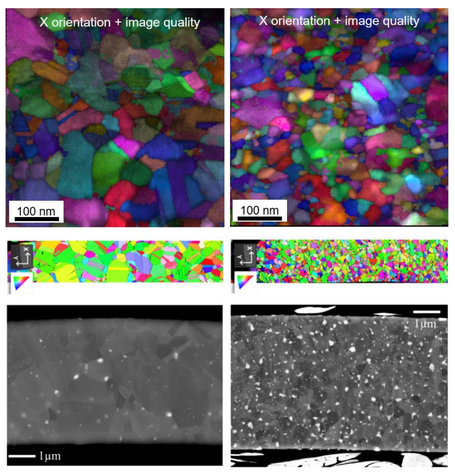
Design and development of salient features



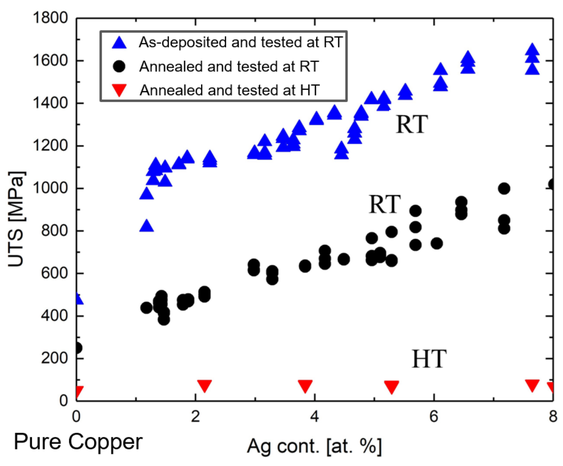
Proof of concept

Microstructure and micro tensile characterization of Cu-X thin film systems at various temperatures and conditions

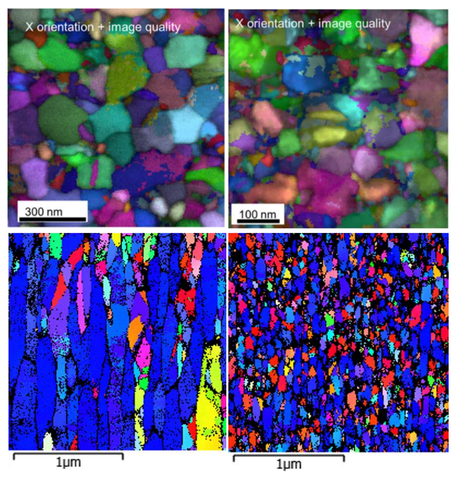




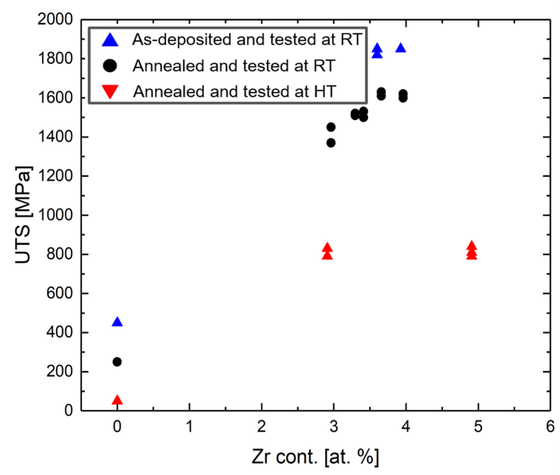
As-deposited and annealed Cu-Ag microstructures (1 at.%, 8 at.%)



Evolution of UTS with temperature in various Cu-Ag alloy concentrations



As-deposited and annealed Cu-Zr microstructures (1 at. %, 5 at.%)



Evolution of UTS with temperature in various Cu-Zr alloy concentrations

Summary: Device development

- Hot stages with symmetric temperature distribution along the two arms and localized central heating sources
- A series of thermocouples along the both arms providing temperature control of only ±2.5 °C at 600 °C using a reference sample
- Faster stabilization times of less than 10 minutes at 600 °C

Summary: Cu-X alloy characterization

- Cu-Ag and Cu-Zr libraries were characterized with micro-tensile geometries
- Cu - Ag system showed a lot of gain in UTS but didn't retain that at higher temperatures
- Cu - Zr binary retained the strength even at higher temperatures at the expense of some conductivity

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[1] **V. G. Arigela**, T. Oellers, A. Ludwig, C. Kirchlechner, G. Dehm. Rev. Sci. Instrum. 90, 073904 (2019); https://doi.org/10.1063/1.5086261

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