High resolution insights into structure and corrosion properties of Mg-Al-Ca composites

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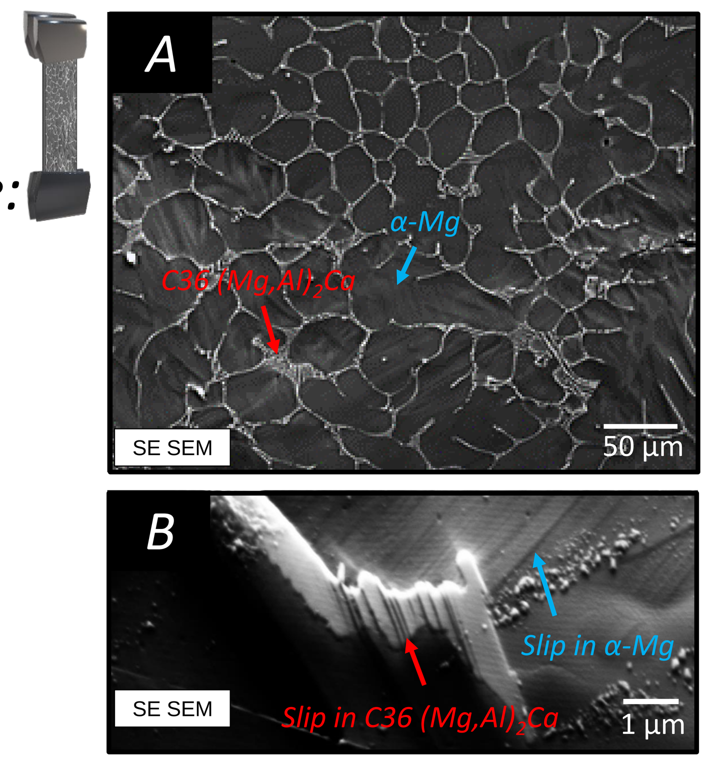
Material motivation

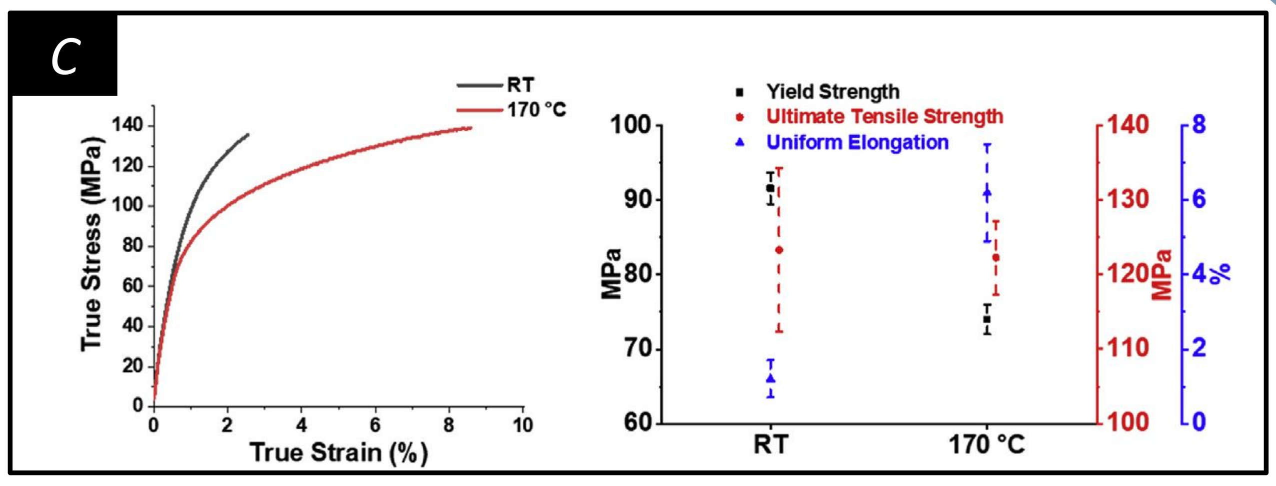
***Mg-Al-Ca composites** with dual-phase microstructure:*

- *hexagonal close packed Mg matrix (soft)*
- *skeleton of strengthening C36 Laves phase (hard)*

Why Ca addition in Mg-Al alloys?

- ***suppresses** the formation of the $Mg_{17}Al_{12}$ phase (with a low thermal stability)*
- ***promotes** the formation of harder **Laves phases** (eg. C36) **with a higher thermal stability** [1]*





Excellent high-temperature creep resistance *due to presence of the strengthening skeleton of intermetallic Laves phases in the soft Mg matrix.*

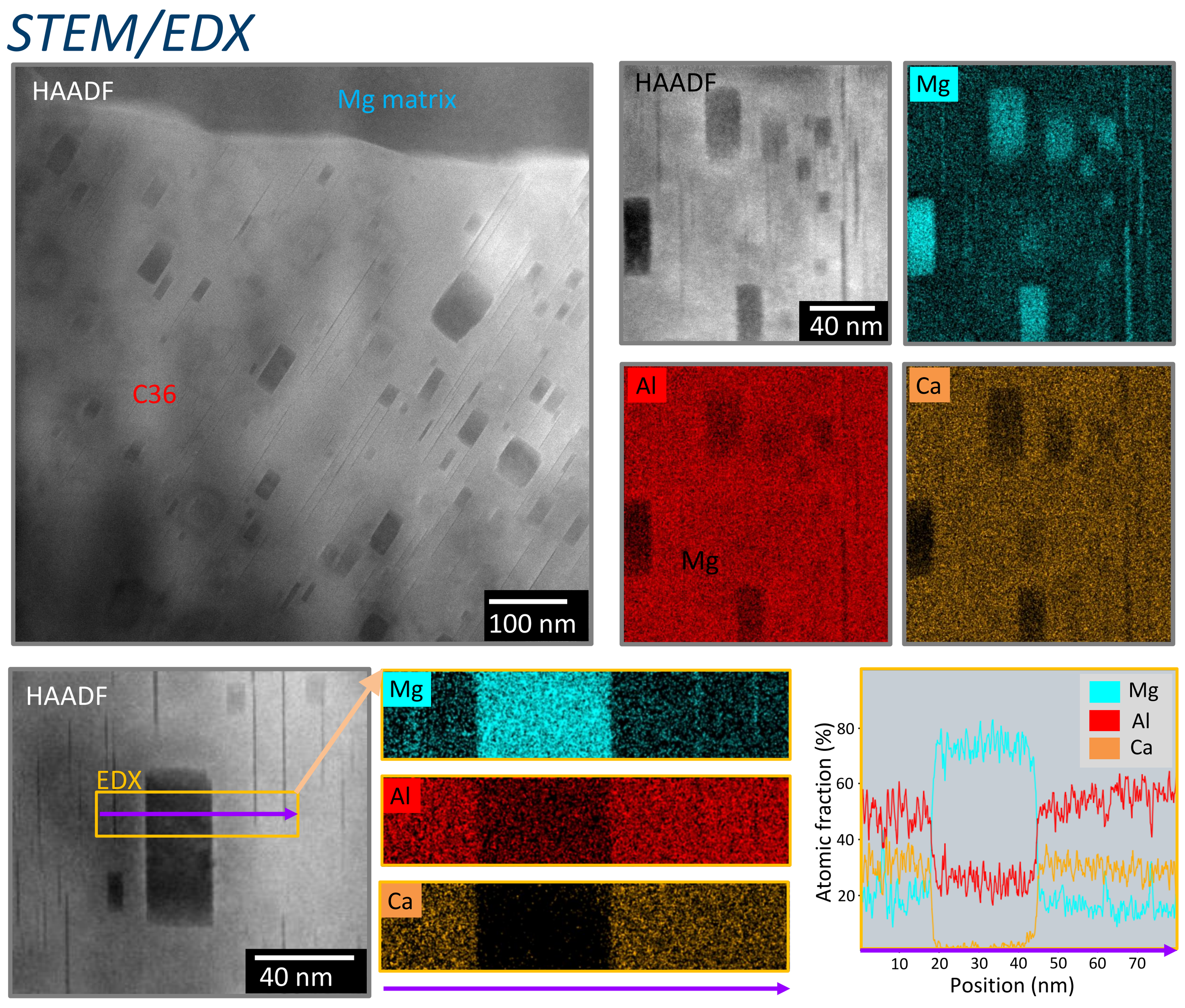
[1] Muhammad Zubair et al., Materials & Design 225 (2023), 111470

Correlative STEM/EDX - APT investigation of the alloy nanostructure

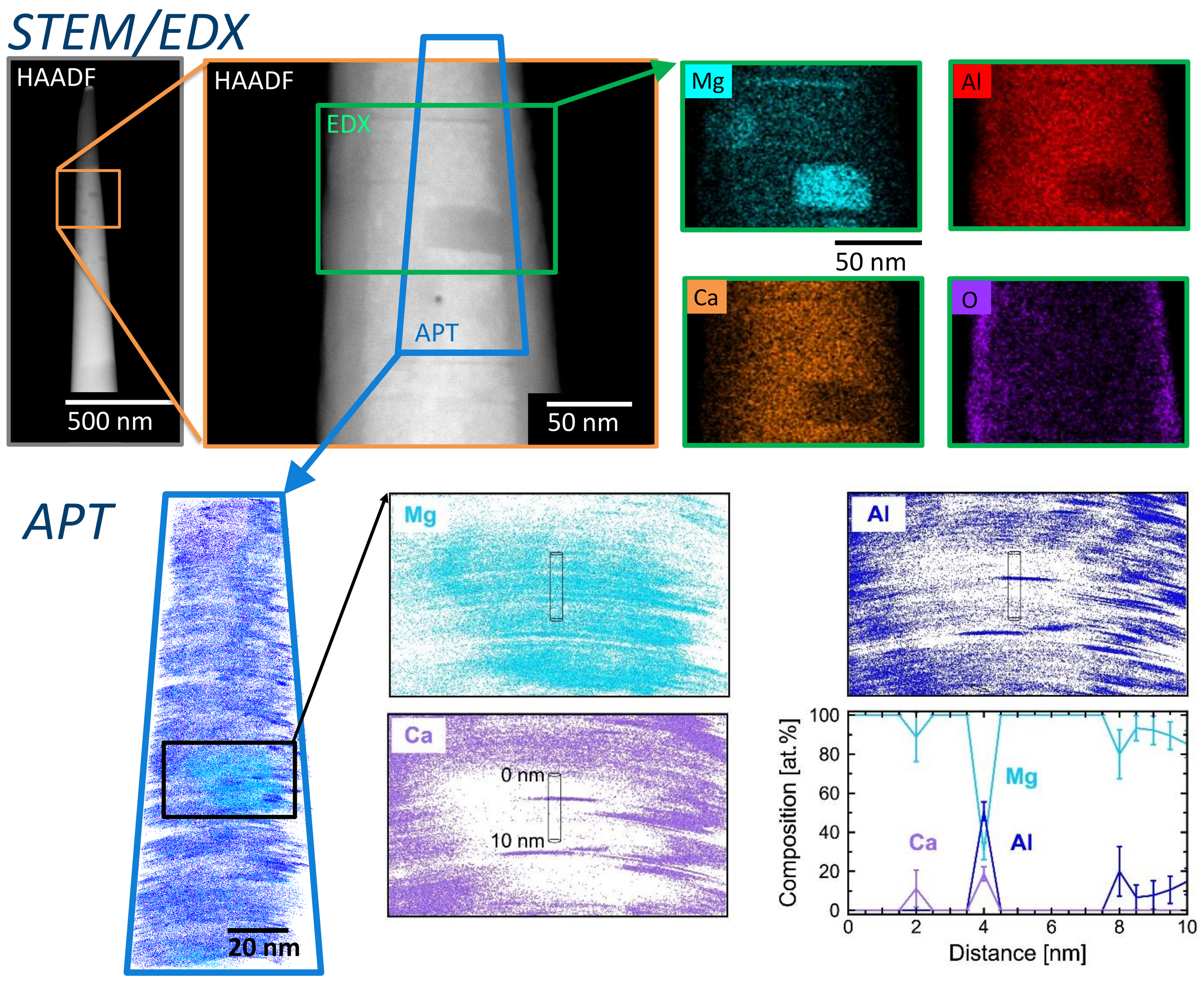
Scanning Transmission Electron Microscopy (STEM) with Energy-Dispersive X-ray (EDX) spectroscopy revealed presence of Mg-rich nanoprecipitates and planar defects within the C36 Laves phase skeleton. By correlative application of Atom Probe Tomography (APT), the spatially-resolved composition was determined.

Maximum values for Mg enrichment measured in nanoprecipitates with the aid of STEM/ EDX approached 80 at.%. The APT analysis revealed their exact chemistry reaching 100 % of Mg and significant chemistry variations, not detectable by STEM!

STEM/EDX



STEM/EDX



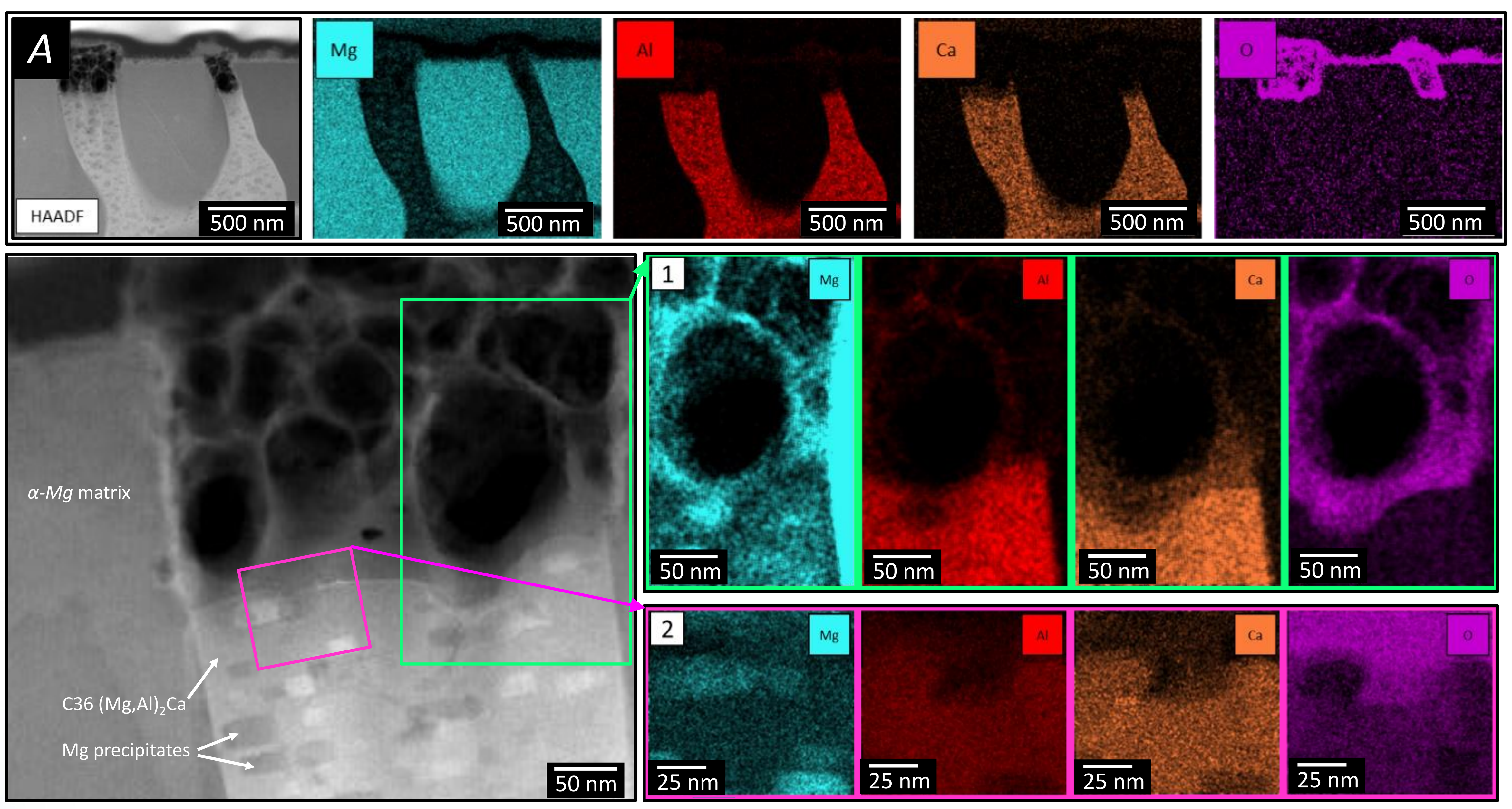
STEM/EDX insights into the corrosion structure

Electrochemical corrosion resistance and the underlying corrosion mechanisms were investigated in an alkaline electrolyte (pH=11.5±0.1).

The C36 Laves phase containing Mg-rich nanoprecipitates exhibited lower dissolution kinetics than expected for pure C36.

The nm-scale Mg-rich precipitates might form a local stable quasi-passive layer and reduce dissolution of C36 Laves phase.

Mg-rich nanoprecipitates tend to inhibit the corrosion kinetics of investigated material.



Corrosion behavior of the Mg-Al-Ca alloy in an alkaline electrolyte (pH=11.5±0.1). The corrosion, front characterized by HR STEM, revealed varying oxide stabilities for the Mg matrix and the secondary phases.