Grain boundary wetting transition in Al-Mg alloys

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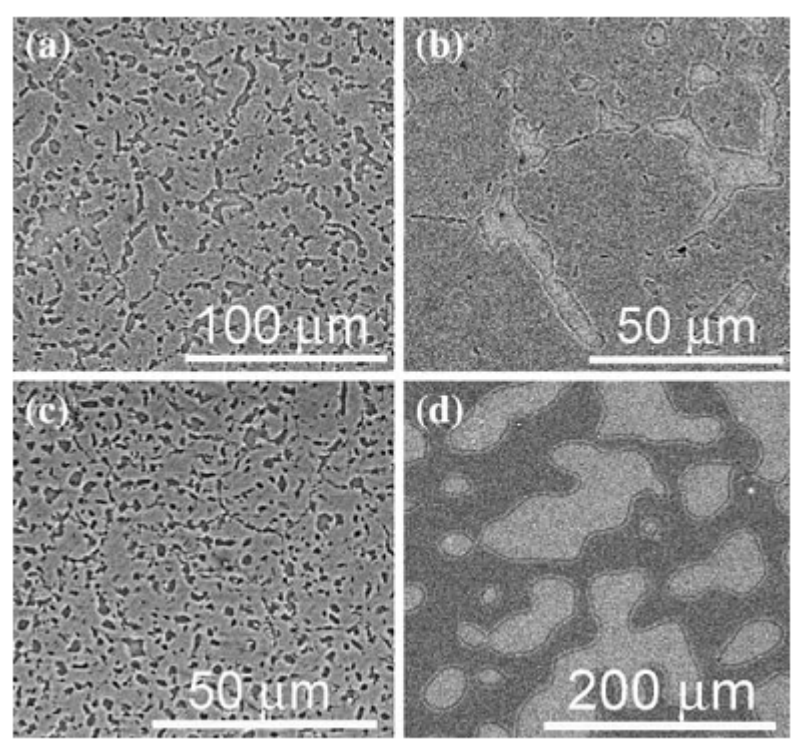
Motivation

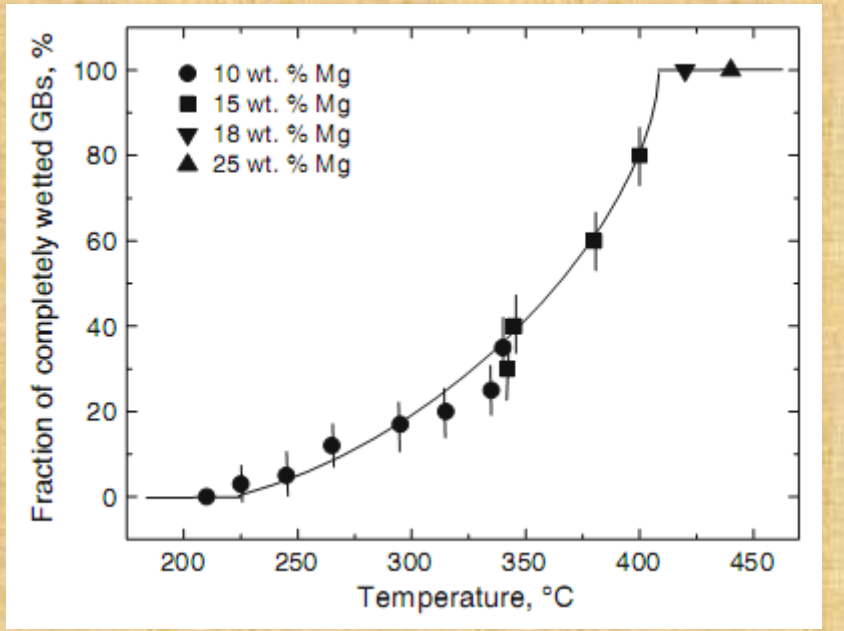
- Observe wetting transition behavior of beta-phase at GB during ageing .

- Detailed characterization of Al-5083 sample with sub-angstrom resolution.

Wetting of Al GB by crystalline Al_3Mg_2 phase



SEM micrograph of Al-Mg alloy
a 210°C b 225°c c 335°c d 420°c



Temperature dependence of the wetting fraction of Al_3Mg_2 phase in the GB

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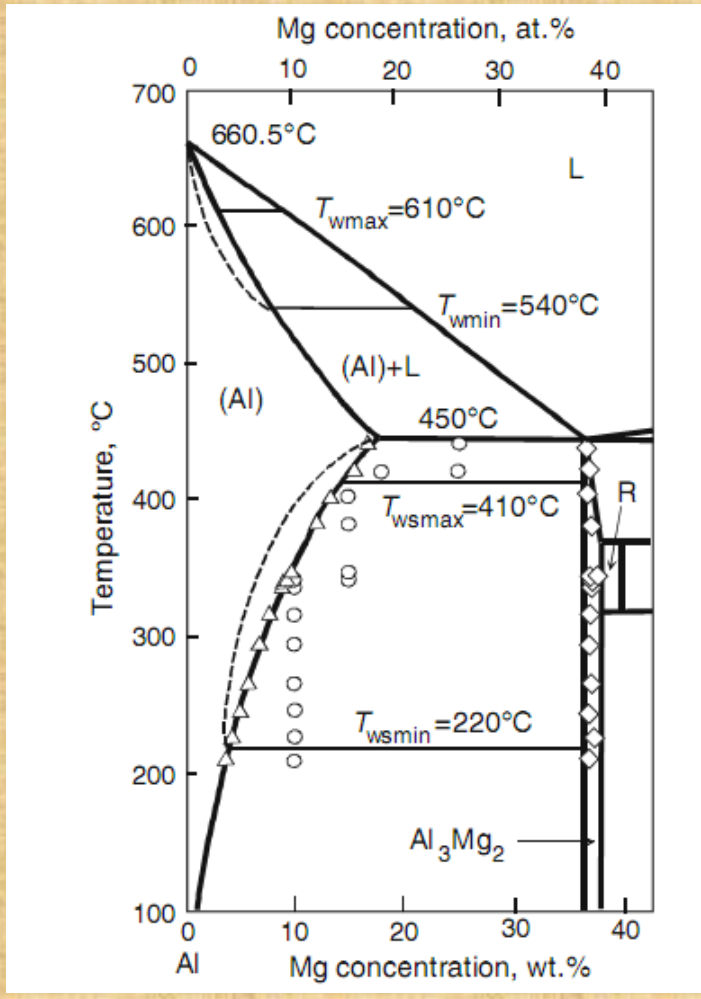
Wetting of Al GB by crystalline Al_3Mg_2 phase



Part of Al-Mg phase diagram

Twsmax and Twsmin for the GB wetting by the second phase

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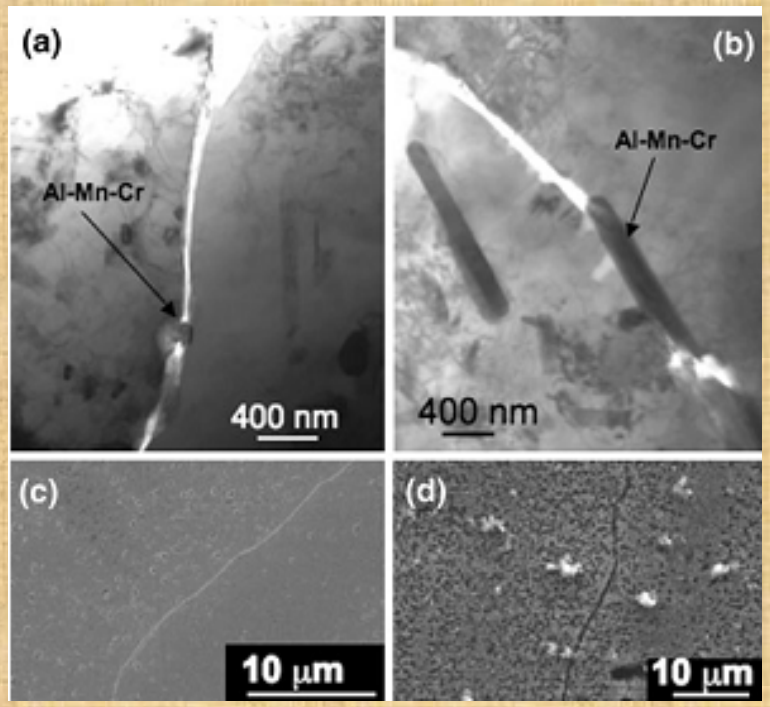
Background_Silver Bridge Collapse

SCC caused the catastrophic collapse of the Silver Bridge in December 1967, when an eyebar suspension bridge across the Ohio river at Point Pleasant, West Virginia, suddenly failed. The main chain joint failed and the whole structure fell into the river, killing 46 people in vehicles on the bridge at the time. Rust in the eyebar joint had caused a stress corrosion crack, which went critical as a result of high bridge loading and low temperature. The failure was exacerbated by a high level of residual stress in the eyebar. The disaster led to a nationwide reappraisal of bridges.

http://en.wikipedia.org/wiki/Stress_corrosion_cracking

Dissolution of beta-phase in salt water



TEM and SEM images showing the dissolution of beta phase when it is exposed to salt water.

Stress corrosion cracking (SCC) is a consequence of the formation of the grain boundary beta-phase, Al_3Mg_2, which is anodic relative to the Al matrix

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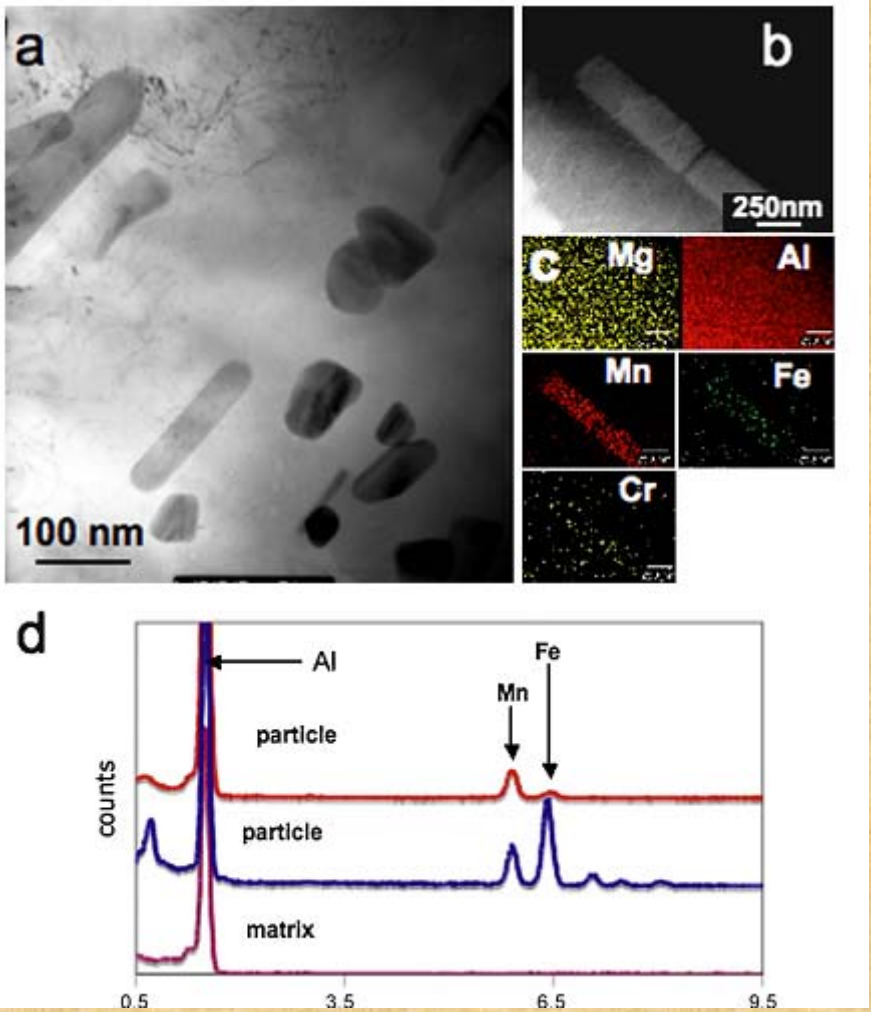
Samples

- As received sample (H-131 temper condition)
- Annealing samples (at 175^{o}C for1, 10, 25, 50, 100,240, 500, 1000)

As-received sample- NO beta-phase



Al-Cr-Mn rods either at GB or in the matrix

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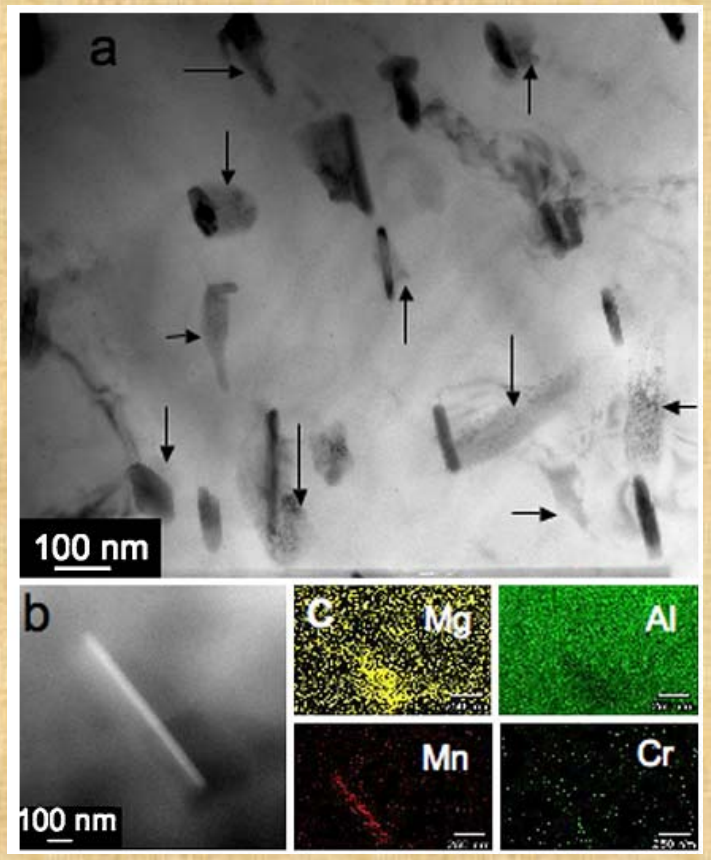
Annealed sample- Beta phase comes out at the rods



Beta-phase is mostly found at the GB or nucleating at the rods.

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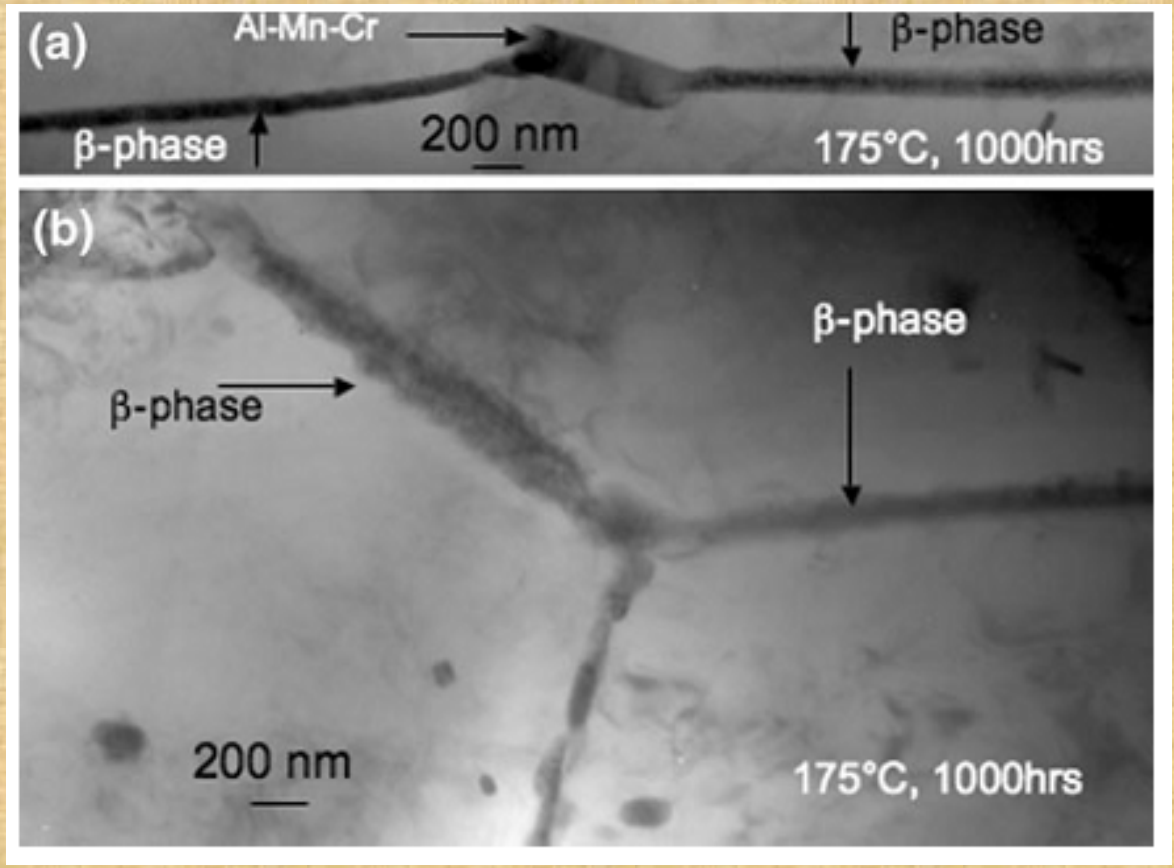
Annealed sample- Beta phase comes out at the grain boundary



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Future work 1

- Imaging Al-5083 sample with atomic resolution
- Atomic chemical analysis or column by column chemical identification

Future work 2

- (Imaging) Real time observation of the evolution of beta-phase at the grain boundary utilizing hot stage, including the nucleation and growth of beta-phase
- (Chemical Imaging) In-situ monitoring the chemical variation of Mg and Al in the sample
- Investigate the role of aging temperature on the wetting transition of beta-phase

Future work 3

- Techniques developed to overcome the low contrast at the GB (the atom mass of Mg is smaller than that of Al), such as, surveying a suitable collection angle, the combination of Bright Field (BF) mode with High angle annular dark field (HAADF) mode.

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Thanks for attention!