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Hydrogen Trapping and Embrittlement in High-Strength Al Alloys

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Environmentally assisted embrittlement of high-strength Al alloys hinders their wide application. The important role of hydrogen (H) associated with the H "embrittlement" mechanism occurs. However, the challenge of assessing the precise trapping sites of H makes the mechanisms remain ambiguous. Here, we used atom probe tomography to investigate H associated with specific microstructural features in an Al-alloy that until now was not reported. We successfully achieved visualization and assessment of H at second-phases and grain boundaries, with the enrichment of one order of magnitude higher as opposed to the Al matrix. We used these observations to guide atomistic ab initio calculations, which show that the co-segregation of alloying elements and H favours grain boundary decohesion, and the strong partitioning of H into the second-phase particles removes solute H from the matrix, hence preventing H embrittlement. Our insights further advance the mechanistic understanding of H-assisted embrittlement in Al alloys, emphasizing the role of H traps in minimizing cracking and guiding new alloy design.

Reference:

[1] Huan Zhao, Poulami Chakraborty, Dirk Ponge, Tilmann Hickel, Binhan Sun, Chun-Hung Wu, Baptiste Gault, Dierk Raabe. Nature **602**, (2022), p. 437–441. doi:10.1038/s41586-021-04343-z