

Investigating the effect of thickness on the fracture toughness of thin metallic sheets focusing on Al2050

S. Javangorouh ^{1*}, T. Pardoen ¹, A. Kaniadakis ¹, M.S. Colla ¹, V.D. Nguyen ²

¹UCLouvain, iMMC, Place Sainte Barbe 2, 1348 Louvain-la-Nueve, Belgium

²University of Liege, A&M, School of Engineering, Quartier Polytech 1, 4000 Liège, Belgium

Fracture toughness is a critical parameter in material selection and structural design. For thin metallic sheets, fracture toughness is not solely an intrinsic material property but is also strongly influenced by sheet thickness. Previous studies have shown that fracture toughness increases with sheet thickness, reaching a peak at low thicknesses, and then decreases and stabilizes to a plateau in the plane-strain regime [1]. However, the exact location of this peak and the underlying mechanisms remain inadequately studied.

This study integrates both experimental and numerical approaches to address these gaps. The experimental investigations focus on aluminum alloy Al2050-T8, employing the Crack Tip Opening Displacement (CTOD) method on Double-Edge Notched Tension (DENT) specimens. A wide range of thicknesses is tested to accurately capture the influence of sheet thickness on fracture toughness and identify the critical peak.

On the numerical front, initial simulations of fracture toughness have been performed using the J2 elastoplastic model in both 2D and 3D frameworks. Future work involves using an advanced non-local Gurson–Tvergaard–Needleman (GTN) model, which incorporates mechanisms of void nucleation, growth, and coalescence. This model is expected to more effectively capture crack initiation and, consequently, the thickness-dependent trends in fracture toughness of thin sheets [2].

The study also investigates the role of strain hardening in influencing fracture toughness. While previous simulations relied on the Swift hardening law, this research plans to implement the Kocks-Mecking strain hardening law, which accounts for four distinct hardening stages and will be integrated into the GTN model for improved precision.

By combining experimental insights with numerical modeling, this research aims to provide an understanding of the interplay between thickness, strain hardening, and fracture toughness. The findings will contribute to the optimization of lightweight, high-performance structures.

References

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* Corresponding author

Email: sara.javangorouh@uclouvain.be