Impact of titanium alloying on the microstructural and mechanical behavior of low-carbon steel sheets for automotive applications.

Amel SAMET, Latifa ARFAOUI, Amna ZNAIDI*

National School of Engineers of Tunis, University of Tunis El Manar, Laboratory of Applied Mechanics and Engineering (LMAI), Tunisia

**amna.znaidi@ipeiem.utm.tn*

Résumé pour poster

Low carbon steels are widely used in automotive manufacturing due to their excellent ductility, formability, and cost-effectiveness. Among these, titanium-stabilized interstitial-free steels (IF-Ti) offer enhanced properties compared to conventional low carbon (LC) steels. This study investigates the influence of titanium on the microstructural and mechanical behavior of cold-rolled and annealed steel sheets. Mechanical properties were evaluated through uniaxial tensile testing, while crystallographic textures were analyzed using neutron diffraction. Scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX) were employed to characterize grain structure and precipitate morphology.

Results reveal that IF-Ti steel exhibits a sharper γ-fiber texture, finer grain boundaries, and the absence of Lüders bands, indicating improved recrystallization behavior and strength. In contrast, LC steel shows a more heterogeneous deformation response, linked to a high density of fine AlN and MnS precipitates, which hinder dislocation mobility and promote localized deformation. To further quantify the strain-hardening behavior, Voce-type constitutive models were fitted to the experimental stress-strain curves. The classical Voce law accurately captured the homogeneous hardening behavior of the IF-Ti steel. However, the LC steel required a double Voce formulation to describe its dual-stage hardening, characterized by a rapid initial strengthening followed by gradual saturation. These modeling results underscore the need for advanced constitutive laws when describing the complex plasticity of multi-phase industrial steels.

These findings highlight the beneficial role of titanium in refining the texture, strain hardening behavior, and mechanical performance of low carbon steels for automotive body applications.