Liquid metal embrittlement is normally studied using hot deformation tests when the susceptible alloy has been immersed in the liquid embrittler during the tensile tests. This approach cannot simulate the conditions of a real resistance spot welding which is the main joining process used in assembly lines of automotive industry. This work concern the studying the basic aspects of liquid metal embrittlement of high manganese austenitic twinning induced plasticity steels during their resistance spot welding; a approach which has not been attempted ever. The nature of grain boundary decohesion induced by liquid zinc was disclosed using experimental results aided by simulations and *in-situ* observation. The phenomenological features of the liquid metal embrittlement was disclosed by explaining its characteristics, requirement for occurrence, underlying cause and mechanisms involved. Simulations indicated that LME occurs when the critical stress required for LME is satisfied while there is enough liquid zinc for LME at supercritical area for cracking; a location, which experiences the maximum temperature and maximum tensile stress. Simulation results indicate that liquid zinc has a maximum time of ۰,۰۳۹۳ second to interact with the surface grain boundaries for the nucleation of LME induced cracks suggesting the diffusion-based mechanisms cannot have a significant contribution in the crack nucleation stage. The present study also gave a detailed description of the most promising mechanisms for LME of TWIP steels during RSW. Briefly, it can be said that LME induced cracking includes crack nucleation and crack propagation. In the nucleation stage, the liquid zinc has a dominant effect while in its propagation the role of the tensile stresses at the crack tip is more predominant. However, *in-situ* observations showed the evacuation of liquid zinc aided by grain boundary wetting rapidly tra  orts the liquid zinc to the tip of the propagating crack in order to weaken the grain boundary cohesion for more propagation. It seems that the better understanding of nature of LME described here will be beneficial in order to modify embrittlement behavior in the steels.

***Keywords:*** Liquid metal embrittlement (LME); Twinning induced plasticity (TWIP) steel; Grain boundary decohesion; Simulation; *In-situ* observation; Hot deformation test (HDT); Resistance spot welding (RSW).