Evolution of the fatigue resistance of silicon-rich TRIP steel after hot-dip galvanization

S. Aden-Ali[a], A. Chamat[a], J. Gilgert[a], E. Petit[c], M. Gilles[d], S. Dominiak[b], Z. Azari[a]

[a]LFM – ENIM, Université de Metz, F-57045 Metz Cedex 01, France
[b]LPMM, Université de Metz, F-57045 Metz Cedex 01, France
[c]LETAM, Université de Metz, F-57045 Metz cedex 01, France
[d]Umicore Research, B-2250 Olen, Belgium

High strength steels, including TRIP steels, are designed to produce strong but light structures. Application in the automotive industry could contribute to energy saving due to improved lightweight.

Hot-dip galvanization is the most efficient and cost-effective way to protect steel against corrosion. Hot-dip galvanization of high strength steels like TRIP steels is a challenge because the mechanical performances of these materials rely on microstructures produced after a complex and precise thermomechanical route. **Now in general galvanisation,** parts are dipped in melted zinc at ~450°C during 4 to 10 minutes. These temperature and duration are possibly able to modify the microstructure of TRIP steels.

In this paper, we report on the evolution of mechanical properties and fatigue resistance of a silicon-rich TRIP steel after galvanization. Several mechanisms potentially responsible for the modifications have been assumed and evaluated.

The mechanical behaviour of trip steels is **not thouroughly** changed after galvanization. On the contrary, the endurance upon cyclic loading is strongly reduced.

The usual hypothesis invoked in order to explain such effects include : - the propagation of cracks produced in the delta intermetallic layer at the interface between the zinc and the steel substrate, - the modification of the steel microstructure due to the thermal treatment, - the embrittlement of grain boundaries of the steel due to diffusion of alloy additives like tin or bismuth.

Our results are not compatible with these mechanisms. As a matter of fact, cracks produced after solidification into the delta layer are found to propagate after cyclic loading. However, we found no evidence of their propagation into the steel substrate. No traces of elemental additives were found at grain boundaries on the fractured surface neither. Finally, samples of TRIP steel which underwent similar thermal treatment in a salt bath displayed improved fatigue resistance.

Alternative hypothesis are now under study.