I. Introduction

Background: Martensite/ferrite (M/F) interface damage largely governs the failure of dual-phase (DP) steels, which are among the most attractive advanced multi-phase steels for automotive applications.

Goal: A multi-scale modelling framework for predicting the M/F interface damage initiation, which takes the relevant microphysics into account.

Motivation-1: Direct numerical simulations of DP steel microstructures are computationally prohibitive.

Motivation-2: Martensite substructure boundary sliding mechanism dominates the M/F interface damage initiation.

II. Multi-scale framework

Hypothesis-1: Sliding-triggered M/F interface damage initiation mode is dominating.

Hypothesis-2: Specific M/F interfacial morphology is secondary compared to the sliding mechanism.

Overview

Off-line:
- Perform interfacial zone unit cell simulations
- Post-process BVP solutions
- Construct a unified effective interface damage indicator model by model reduction

On-line:
- Perform simulation on a DP steel mesostructure
- Predict interface damage hot spots

Features:
- One reference master damage indicator + two unified geometrical correction functions
- Calibration only once for a given material
- Prediction of damage hot spots in one step

III. Application

Geometry: A DP steel mesostructure with multiple martensite islands embedded in a ferrite matrix.

Materials: Reduced lath martensite model and isotropic elasto-plastic ferrite model.

Interface damage initiation analysis

Hot spots:
- Around martensite islands with high sliding activity
- Exact locations also depend on interface orientation

References


Email address: l.liu@tue.nl