EFFECT OF ABRASIVE PARTICLE SIZE ON FRICTION AND WEAR BEHAVIOUR OF VARIOUS MICROSTRUCTURES WITH THE SAME CHEMICAL COMPOSITION AND SIMILAR HARDNESS LEVELS

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KEYWORDS

Microstructure; hardness; abrasive wear; friction; abrasive particle size.

ABSTRACT

In the literature, the tribological behaviors in term of wear rate of various microstructures are investigated but only focused on wear and without fixing the hardness and/ or the chemical composition. Additionally, the investigation of the coupled contributions of microstructure and abrasive particle size are still lacking

A contribution is proposed by using of 25CD4 steel pins with various microstructures with the same chemical composition and similar hardness levels (310, 410 and 500Hv). In this study, pins are heat-treated to generate a brittle quenched martensitic microstructure, a tempered martensitic microstructure and three dual-phase microstructures, with different martensite colony morphologies, (Fig.1) for each hardness level. The friction tests are performed between these heat-treated pins against an abrasive paper with different sizes (15µm–200µm) and under different normal loads (50N-110N).

Whatever the hardness, it is shown that dual-phase microstructures, with a soft ductile ferrite phase and a hard martensite phase, present lower friction coefficient and wear rate than single-phase microstructures such as a tempered martensitic microstructure and a brittle quenched martensitic microstructure. For a hardness level of 410Hv, Figure 2 shows this effect of microstructure on friction coefficient and wear rate. Among dual-phase microstructures, granular and coarse martensite colonies present lower friction coefficient than fine and fibrous martensite colonies. This effect of microstructure on friction coefficient and wear rate are similar for the two other hardness levels (310 and 500Hv). In addition, whatever the abrasive particle size, as the normal load increases, these effects of microstructure on friction coefficient are reduced.

Whatever the microstructures and the hardness levels, the friction coefficient is minimized by an intermediate abrasive particle size of 35µm (Fig.2a) because of a transition between adhesive and abrasive wear mechanisms. Nonetheless, as abrasive particle size increases, wear rate and wear debris size increase (Fig.2b).

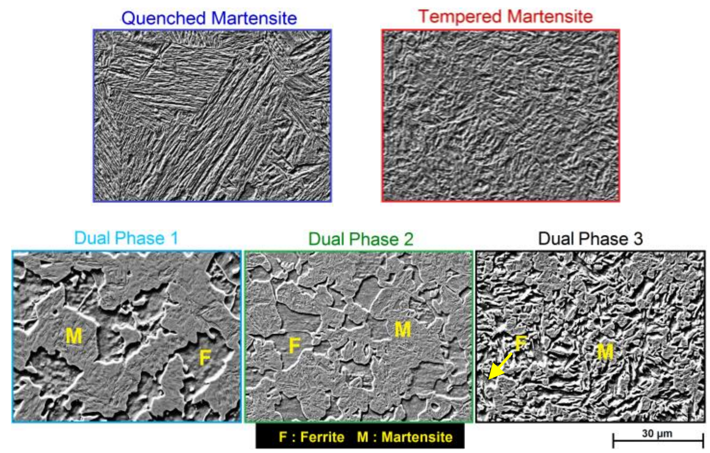

Fig. 1: Scanning electronic micrographs (SEM) of the studied microstructures of 25CD4 steel in the case of the hardness level of 410Hv.

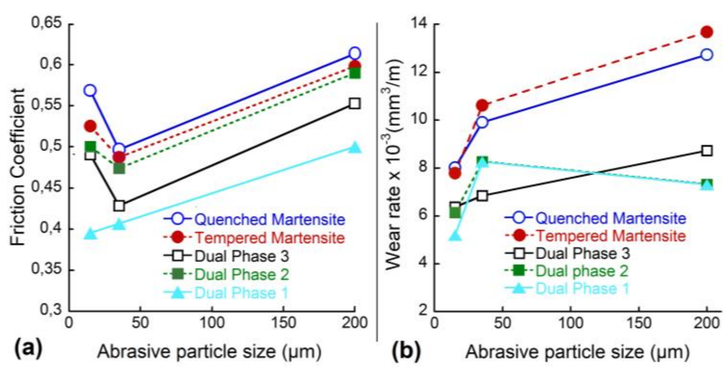

Fig. 2: Evolution of (a) the friction coefficient and (b) the wear rate as function of the abrasive particle size in the case of the hardness level of 410Hv under a normal load of 50N.