Influence of Sliding Frequency on Reciprocating Wear of Mold Steel with Different Microstructures

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1.- INTRODUCTION

Large forged steel blooms are employed to fabricate molds for plastics used in the automotive industry. Each mold is expected to produce a few millions of pieces in its life. Wear under service conditions may be severe and may combine with other stresses to cause crack nucleation and failure.

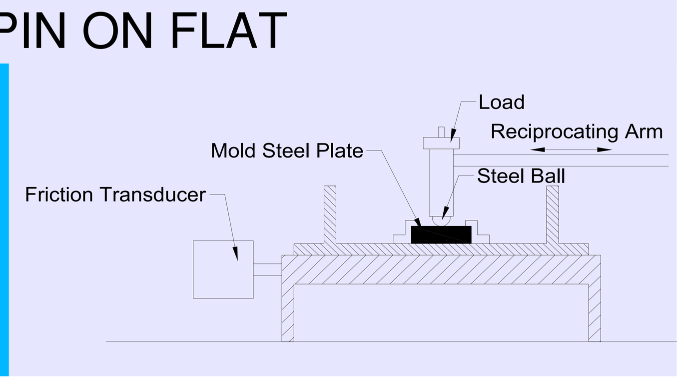
The present manufacturing process consists of machining pre-hardened blooms. The dimensions of the blooms use to exceed the hardenability of the steel, thus different microstructures occur at increasing depths, all of them being affected by the subsequent tempering.

Due to finishing operations, any of the microstructures occurring at different positions in the original bloom can be found at the mold face. Thus, steel properties and wear resistance should be studied as a function of the microstructure.

2.- TRIBOLOGICAL TESTS

RECIPROCATING PIN ON FLAT

PIN:	AISI 52100
PLATE:	MOLD STEEL
LOAD:	10 N
SLIDING FREQUENCY:	1 Hz; 4 Hz; 8 Hz
DISTANCE:	50 m
AMPLITUDE:	5 mm

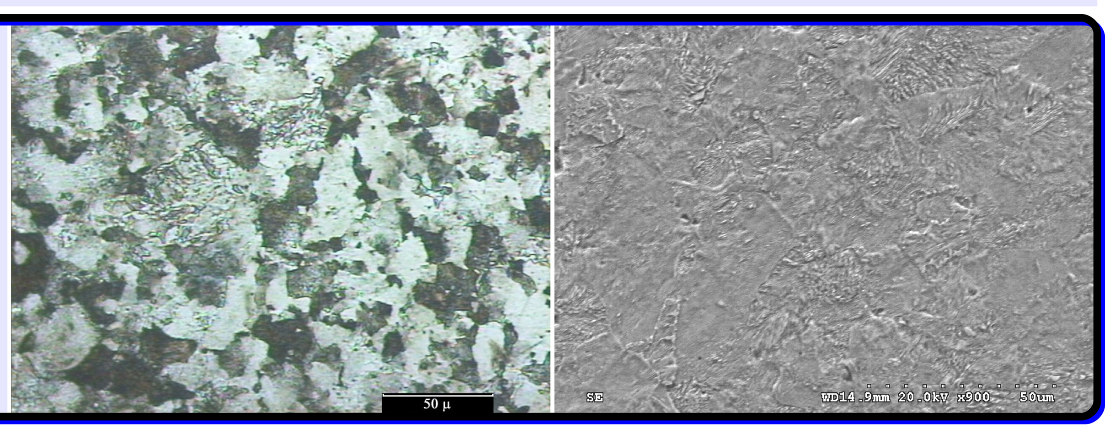


3.- MATERIALS PROPERTIES

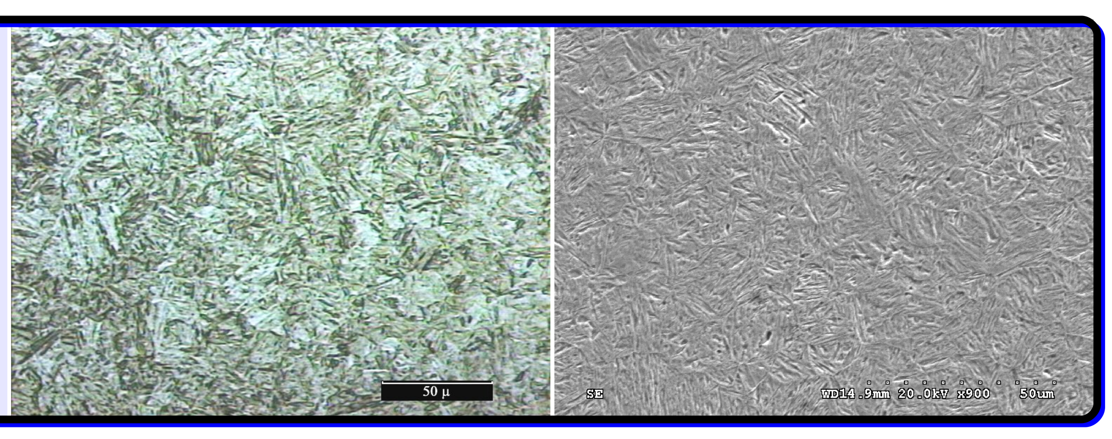
Low Alloy Mold Steel DIN 1.2378

0.38%C; 0.30%Si; 2.00%Cr; 1.50%Mn; 1.10%Ni; 0.20%Mo

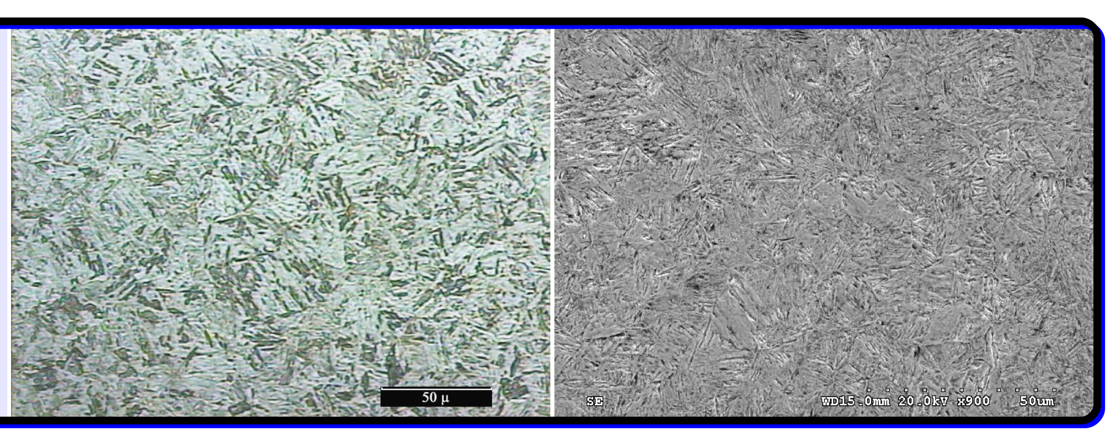
TT4
- Annealed
- Hardness: 26 HRC
- Perlitic and Ferritic Microstructure



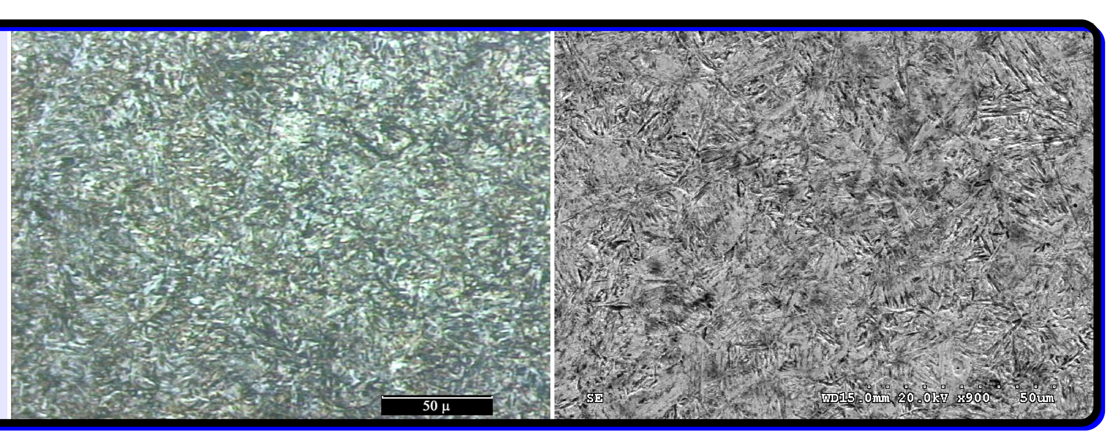
TT1
- Quenched (880°C)
- Hardness: 58.4 HRC
- Martensitic Microstructure



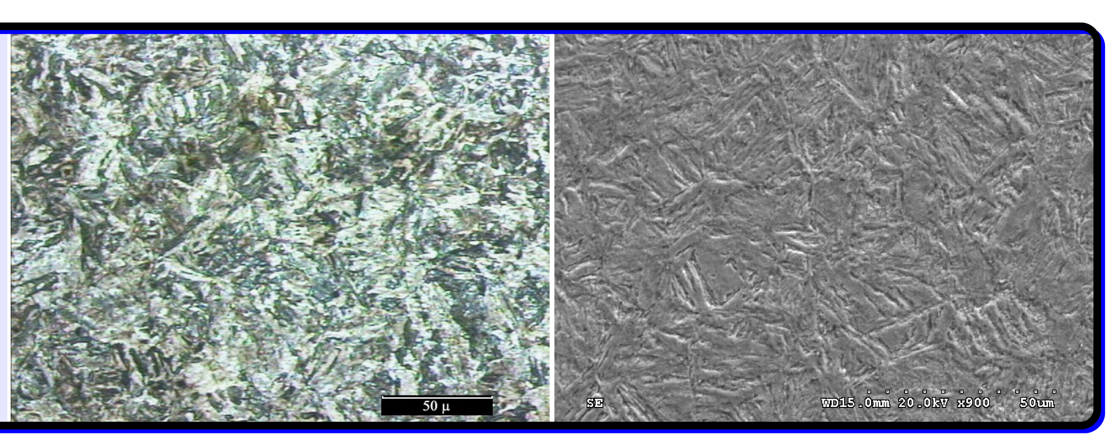
TT3
- Quenched (880°C)
- Tempered (300°C)
- Hardness: 52 HRC
- Martensite and Tempered Martensite



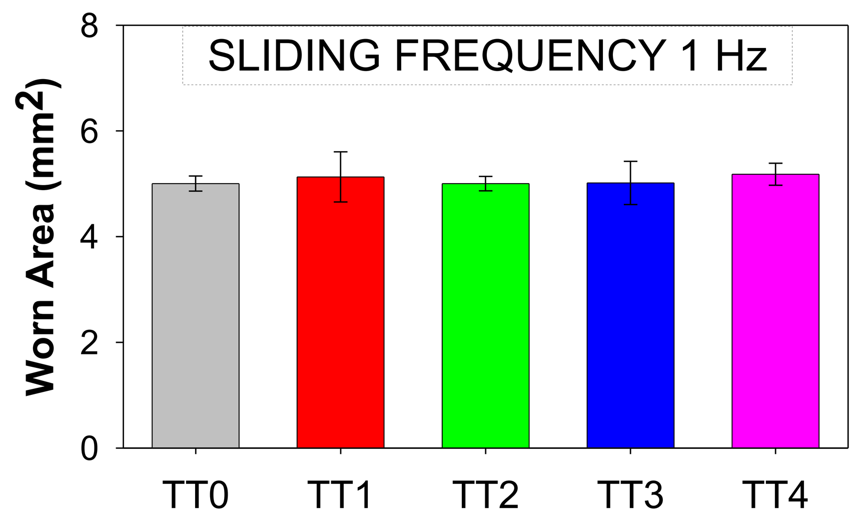
TT2
- Quenched (880°C)
- Tempered (550°C)
- Hardness: 43.4 HRC
- Tempered Martensite, Sorbite and Carbides

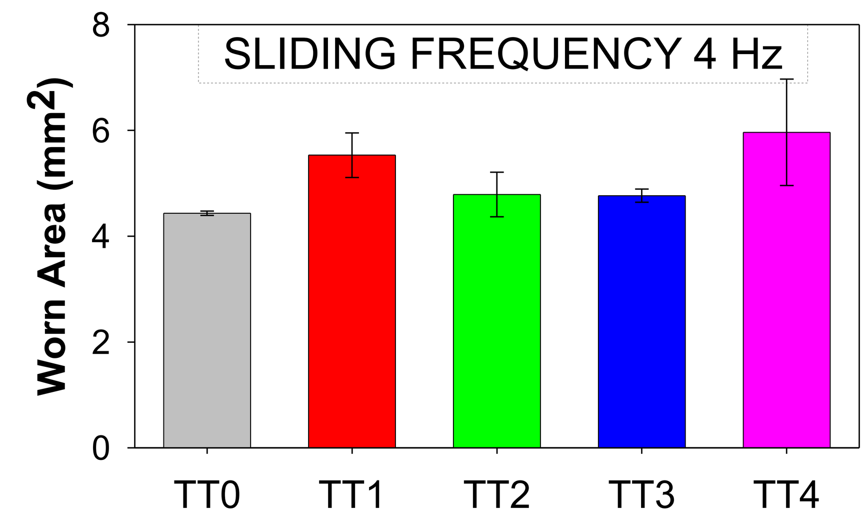


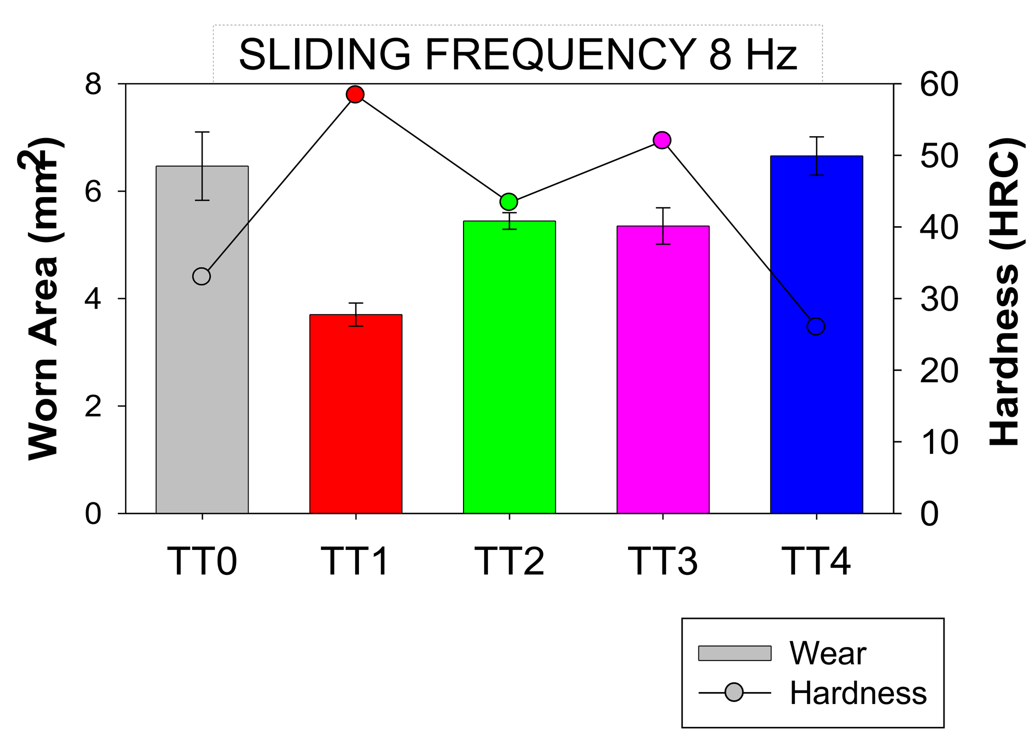
TT0 (as received)
- Quenched (880°C)
- Tempered (650°C)
- Hardness: 33 HRC
- Mix of Tempered Martensite, Sorbite, Ferrite and Perlite



4.- WEAR vs MICROSTRUCTURE



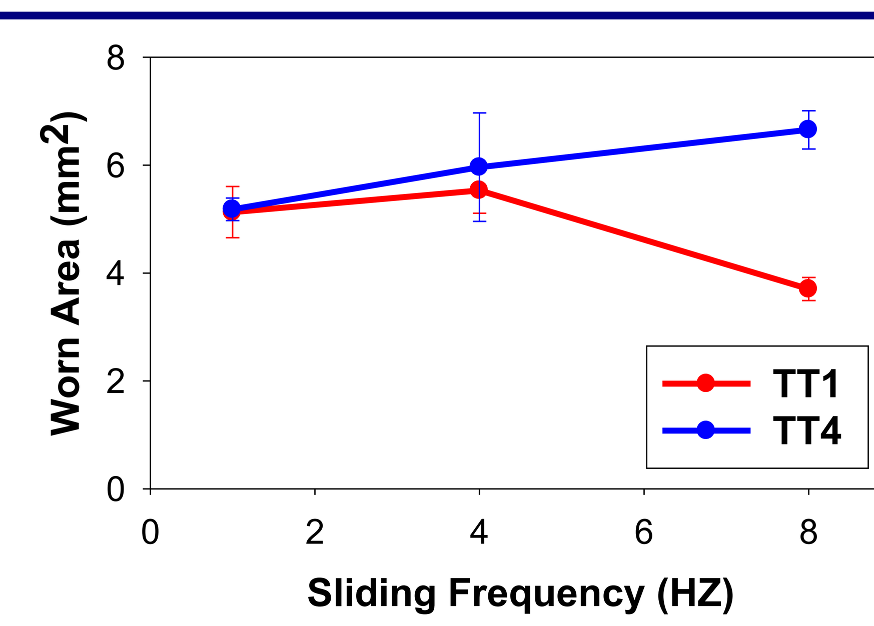




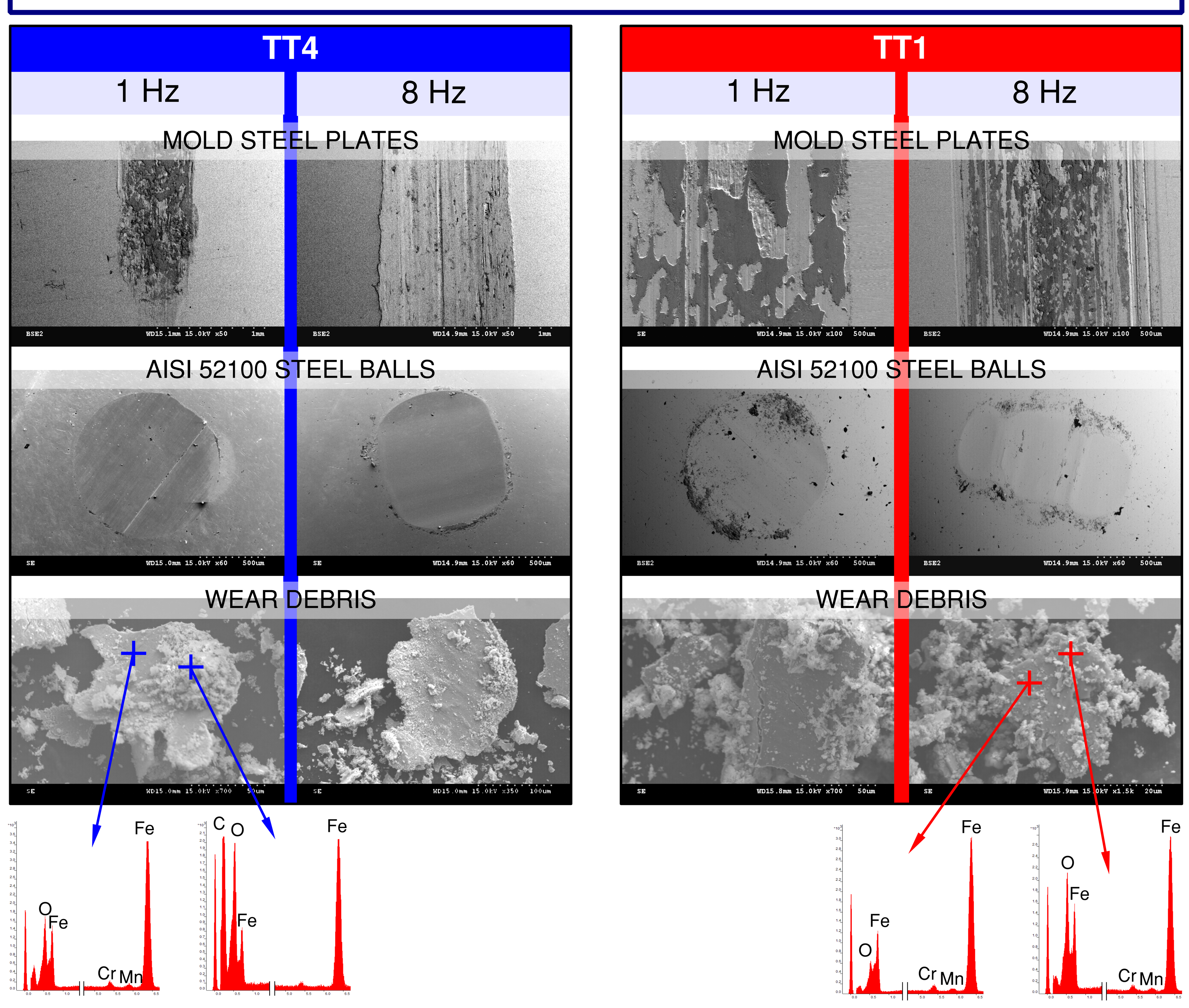
- At low frequency (1 Hz), wear is similar for all the microstructures. At medium frequency (4 Hz), some differences in the wear can be seen. There is a decrease in the wear of mixed microstuctures (TT0) and an increase for martensitic (TT1) and perlitic/ferritic microstructure (TT4).
- At high sliding frequency (8 Hz), the wear is correlated with the hardness of the samples.

5.- WEAR vs SLIDING FREQUENCY

If the sliding frequency is changed for the same microstructure, two behaviours can be observed:
- The softer annealed steel (TT4) increases wear with increasing frequency.
- The harder quenched steel (TT1) decreases wear at high frequencies.



6.- SEM AND EDS ANALYSIS



7.- CONCLUSIONS

✗The wear of mold steel plates is dependent of the microstucture and the sliding frequency.

✗At low sliding frequency (1 Hz), wear is similar for all the microstructures, while at 4 Hz differences between the wear of the different microstructures has been observed.

✗At high sliding frequency (8 Hz), the wear is in agreement with the hardness of the steel.

✗Softer annealed steel (TT4) increases wear with increasing frequency. Harder quenched steel (TT1) decreases wear at high frequencies.

✗The main wear mechanism for all the conditions is abrasion, as can be observed in SEM micrographs. However, there is a component of oxidative wear and the formation of a tribolayer of oxides on the mold steel flat and steel balls.

✗Wear debris are mainly composed of metallic flakes and iron oxides under all conditions.

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