Influence of SiC polytypes on the mixed lubrication regime of self-lubricating composites containing *in situ* generated 2D turbostratic graphite

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Fe-based self-lubricating composites, in which SiC particles act as precursors to *in situ* generated 2D turbostratic graphite as a lubricating phase, were produced via powder injection moulding (PIM). In order to study the precursor influence in the solid lubricant structure and properties, hexagonal (α) and cubic (β) SiC polytypes were used. The composites were tribologically tested in dry and low viscosity oil-lubricated conditions. Distinct precursors did not lead to significant differences between composites. However, due to the high disordered graphite rich tribolayer formation, they do provide lubricity, low friction coefficient, and wear resistance even in oil-lubricated conditions.

Keywords: SiC polytypes, self-lubricating composites, tribology, mixed lubrication regime.

1. Introduction

Self-lubricating composites can provide lubricity under severe conditions; therefore, they are a potential alternative to replace the phosphorous- and sulphur-base lubricant additives [1].

According to literature, the remarkable tribological properties of steel matrix self-lubricating composites with the lubricant phase formed *in situ* by dissociation of SiC are associated with 2D turbostratic graphite formation. This graphite interact with the surfaces, wear particles and atmosphere to form high disordered graphite rich tribolayers in the contact [2].

In this work, hexagonal (α) and cubic (β) SiC polytypes were used to produce self-lubricating composites. The differences between the graphite's formed for each precursor and tribological properties of materials were investigated in dry and low viscosity oil-lubricated scenario.

2. Methods

Two composites (Fe+0,6C+3SiC (α and β)) were produced via PIM using the plasma-assisted debinding and sintering (PADS) process. An SiC free alloy was used as a reference.

Raman spectroscopy (RS), scanning and transmission electron microscopy (SEM and TEM) were used to study the graphite's structures.

Reciprocating cylinder-on-flat tribological tests were performed in dry and oil-lubricated regime. Low viscosity (4.2 cSt at 40 °C) oil containing the BTP antiwear additive was applied in the lubricated tests. Wear mechanisms were investigated by WLI, SEM/EDS, RS and Auger-electron spectroscopy (AES).

3. Results

Ferritic matrix, small rounded pores, and solid lubricant nodules (reservoirs) form composites microstructure. Additionally, a slight difference was observed in matrix hardness (243±4.8 and 217±5.9 HV), while the topography of composites produced with SiC (α) and (β) are similar. Furthermore, TEM and RS analysis show that solid lubricant reservoirs are formed by similar turbostratic 2D graphite for both composites (Figure *1*).

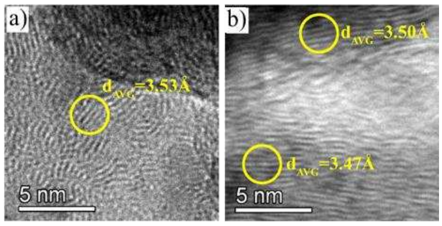

Figure 1: Lamellar distance (d_{002}) of SiC derived graphite (a) α SiC (b) β SiC.

Compared with reference, friction coefficient decreases around 70% and 18% using composites in dry and lubricated conditions. The wear rate of reference is slightly lower than composites, but the counterbodies tested against composites presented wear two or three orders of magnitude lower than those tested against reference, Figure 2.

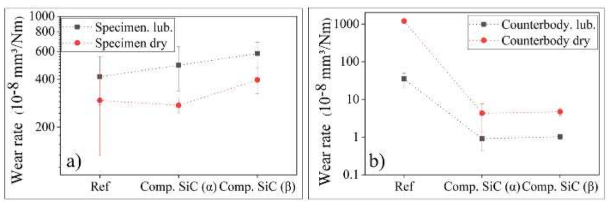

Figure 2: Wear rate in dry and lubricated condition a) Specimen b) Counterbody.

4. Discussion

The difference in tribological performance is due to the formation of high disordered graphite rich tribolayers in the contact, which, as measured by using AES, is around 10 nm thick in lubricated condition.

5. References

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