TRIBOLOGICAL PROPERTIES OF COMPOSITE MATERIALS

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Abstract: *The composite materials are compound of two or more constituents having a distinct interface separating them and which cannot be obtained by any constituent working individually. This paper presents the researches in the area of investigation of the mechanical and tribological properties of the composite materials. For components under various tribological loading conditions, it is indispensible to understand the possible wearing mechanism under precise sliding conditions.*

Key words: composite materials, tribological properties, loading conditions, wearing mechanism

1.Introduction

On contacting of two bodies appears tribological contact which is composed of 4 main elements (figure 1):
-the two bodies in contact A and B;
-mediated around bodies, E
-mediated between the two bodies, generically called "third body" I, which can be a lubricant, oxidation layer, etc.

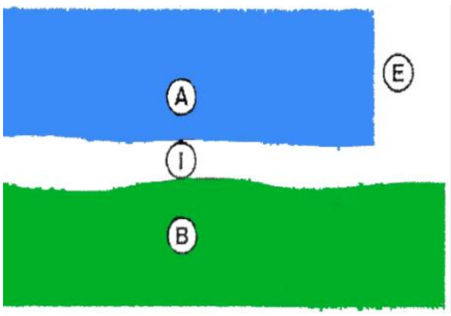


Fig. 1 Elements of tribological contact

To move an object by sliding on the surface of a solid, it is necessary to apply a tangential force to the contact surface, which should be sufficient to overcome the force of friction. In general, the initial tangential force required to make the object starts to slide must be greater than the force applied for continue sliding movement.

This raises the dynamic friction coefficient μ, which is given by the ratio of the tangential force F that makes the subject to slide on the surface of a support and load or normal force, L, which appears in the contact area (figure 2):

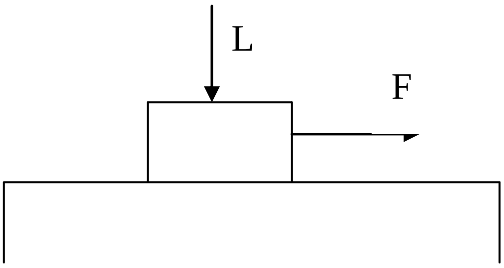


Fig 2 Forces which determine friction coefficient

The coefficient of sliding friction which occurs in a solid surface is primarily dependent on other solid materials that are in contact bodies and the length of the contact surface. During the relative movement of the two solid appear thin layers or films that affect the contact surface friction.

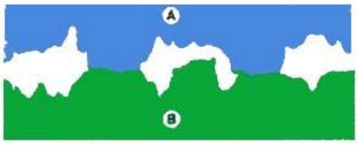
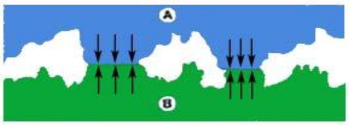
Effects		Contact schematization	Incidents can occur in friction
Stratification			Abrasion resistance Deformations, fractures, rough, etc.
Elastic, plastic deformations	General case		Changing topography: roughness, lift, hardening
	Penetration (Hardness A> B hardness)		Movement resistance Transfer of A to B
Adhesion			Movement resistance

Fig 3: The contact between two solids

The properties of these layers may be different from the properties of materials they are made of solid bodies in contact. At the same time the quality of the surfaces that are in contact influence the bodies friction and irregularities surfaces arising as the corrections or polishing adds to the roughness of surfaces giving rise to crystalline defectives in material or its surface (segregation, structural changes, arising compounds, figure 3) [1].

2.Wear and different types of wear

Wear represents all phenomena that generally lead to loss of weight or significant geometric changes such as loss rates, degradation of surfaces, etc. In table 1 [1] the types of wear are presented and also mode of expression and the causes of their appearance.

Table 1: Types of wear

Types of wear	Way of presence	Causes
Wear through adhesion	- The particles are transferred from one body to another; if the material is of a different nature, the transfer is made from least the hardest body to tenacious body	- In the friction is formed ties (to weld) whose strength is high.
Wear by preload	- Geometric and dimensional changes (generally without weight loss) -cracks, particulate emissions	- Pressures high average or local overpressures which train overrunning elasticity. - Very highensions in relation to the mechanical properties of materials.
Wear through surface fatigue	- Pores and cavities which can be several tens of mm.	- Contracts subject to cyclic stresses rolling, shock, etc.
Abrasive wear - erosion	- Weight loss and / or quota - Scratches, indentations, etc., due to cutting or deformation.	- Abrasion of two bodies: roughness, surface defects; - Abrasion three bodies: hard particles are present at the interface; these particles are free and moves between areas or are incorporated into one another.
Wear by fretting corrosion	- Coloring surfaces -Abrasive wear loss allowances	- Subject to vibration mechanical assembly; - Parts subject to relative motion amplitude poor alternative.

One of the most common usages in the industry is abrasive wear (figure 4) which is manifested by weight loss and/or quota which causes scratches, cavities deformation or cutting.

The abrasion resistance of the material depends on the structure of the microstructure of a number of mechanical properties of materials. Thus, Alison [2] shows that the abrasion resistance of a metal having a cubic structure is two times lower than the abrasion resistance of the metal with hexagonal structure. Krushchov [3], through his studies show that resistance to abrasion for different steels is all the greater as the hardness is higher.

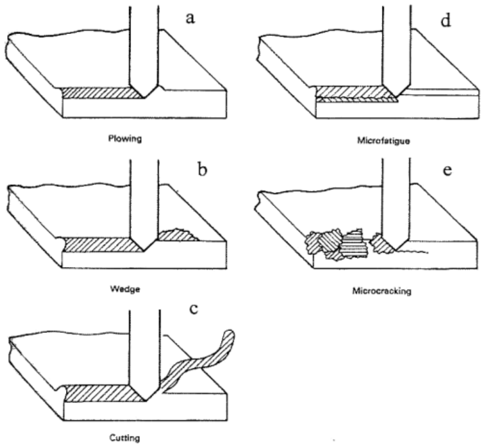


Fig 4: Wear by abrasion [1]

An abrasion test is influenced by many factors as: temperature contact (if it will increase the abrasion resistance is lower), the applied load (the applied load is higher, the abrasion resistance decreases), humidity (may destroy abrasive particles, causing modifying the abrasive and material propertie leading to cracks).

3.Tribological properties of Ni-P and Ni-P / SiC composite materials

Tribological properties of the composite layers are subject to numerous studies. Incorporation of particles having influence on the mechanical, tribological behavior will determine and change of deposits. For this reason most authors studied the influence they have on the toughness composite particles. Zum - Gahr [4] shows (figure 5) that the inherent characteristics of particle composites influences abrasion resistance. He also says that if neizotrope particle orientation and size are parameters that must not be neglected; such a particle built parallel to the surface will be removed more easily than the same particle built perpendicular to the surface.

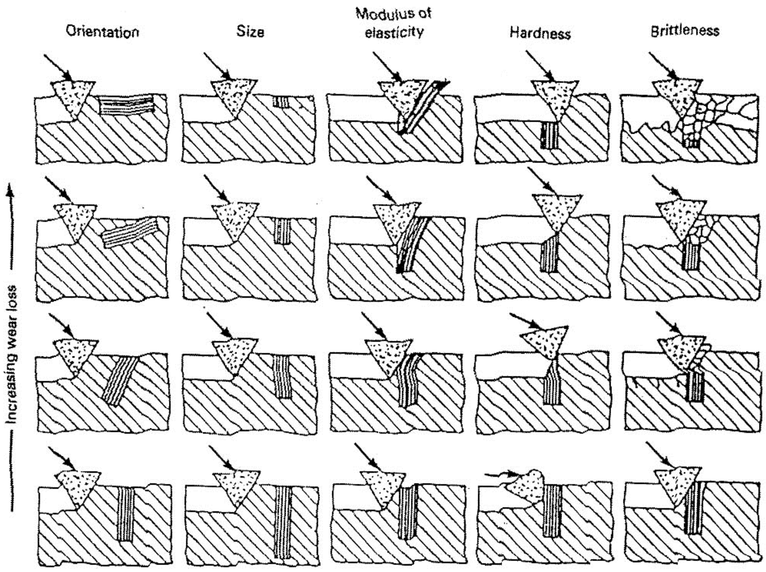


Fig 5: Effect of orientation, size, modulus of elasticity, the hardness and brittleness of the particles on the abrasion resistance

The friction coefficient and weight loss are key features of the behavior of friction materials. For electrolytic deposition Ni-P [1], the friction coefficient varies depending on the concentration of H_3PO_3 electrolyte (Fig 6).

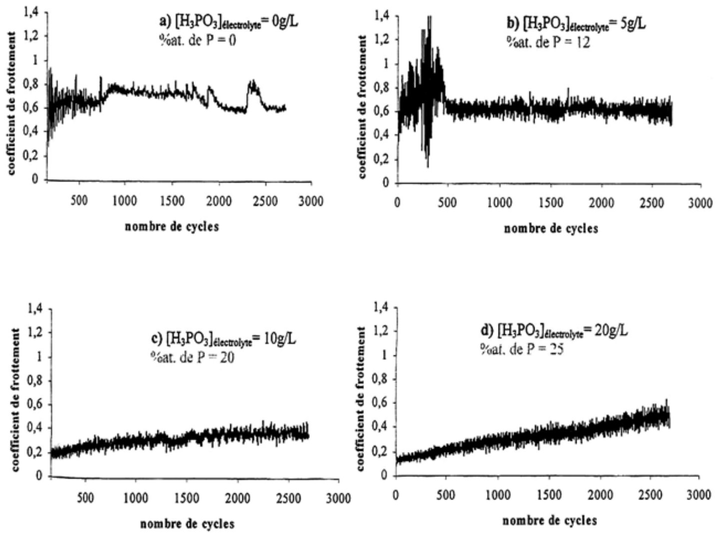


Fig 6: Variation of friction coefficient in H_3PO_3 for different concentrations of the electrolyte for the NiP deposit [1]

For the Ni-P / SiC composite the friction coefficient obtained by nano-scratching tests is shown in figure 7 and it remains almost constant value of 0.35.

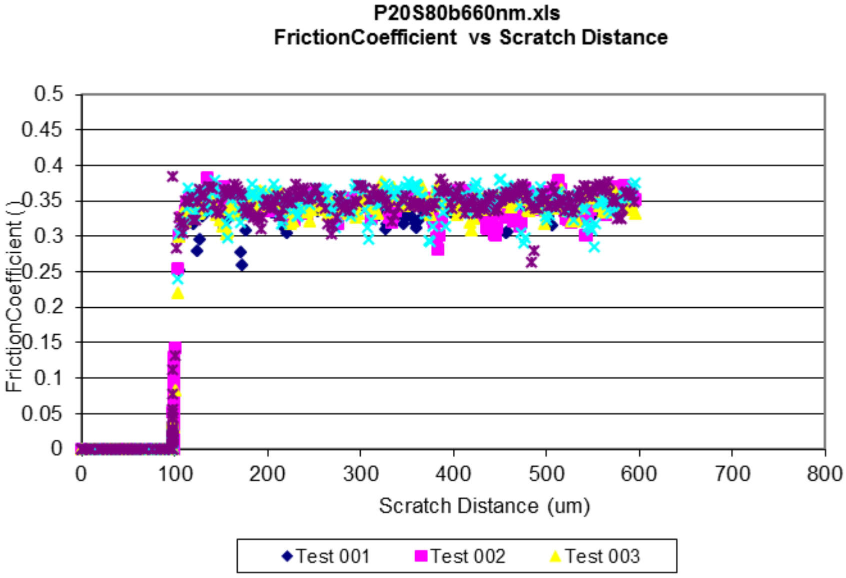


Fig 7: The coefficient friction variation for P20S80 deposition

Conclusion

The coefficient of sliding friction which occurs in a solid surface is primarily dependent on other solid materials that are in contact bodies and the length of the contact surface. During the relative movement of the two solid appear thin layers or films that affect the contact surface friction.

The properties of thin layers of composite materials may be different properties of materials that are made of solid bodies in contact.

Nano-scratching tests performed on Ni-P/SiC composite highlight good adhesion to the sub-layers, as confirmed by obtaining a penetrator-layer friction coefficient between 0.3 and 0.35 and profiles scratches are disturbed by the presence of the silicon carbide particles in the layer.

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