Usura: Introduzione ai meccanismi di danneggiamento e metodi di caratterizzazione/analisi

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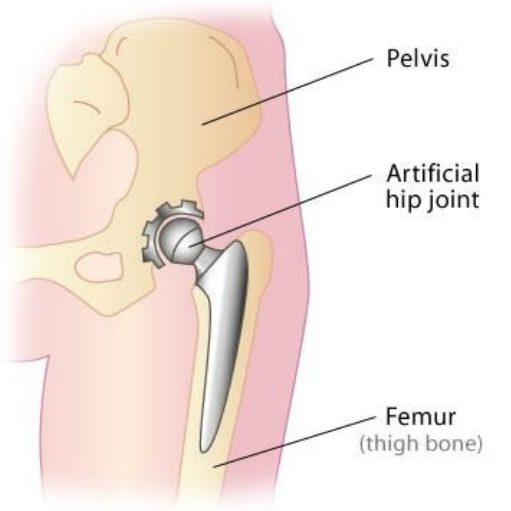
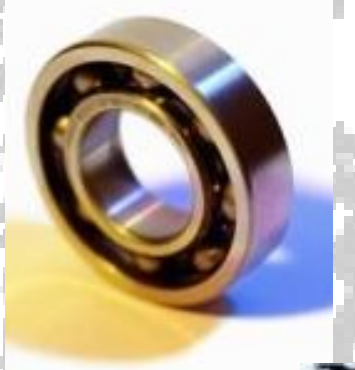
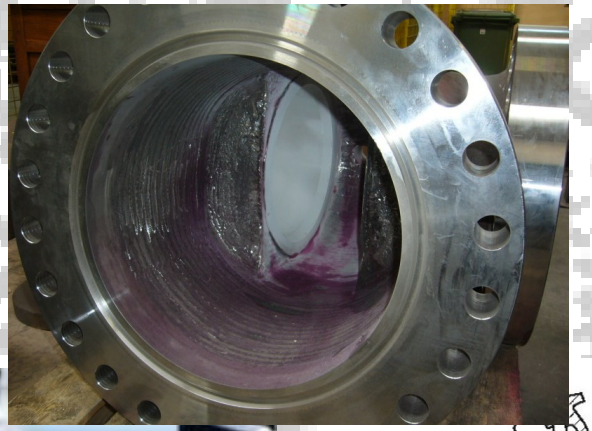
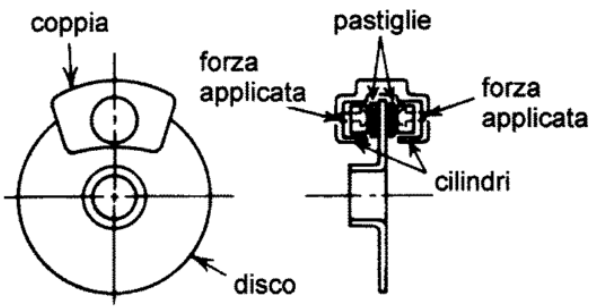
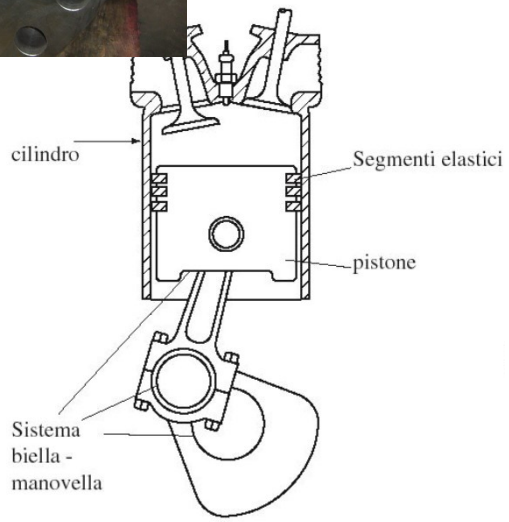
La Tribologia è la scienza che studia l'attrito, l'usura e la lubrificazione di due superfici a contatto e in moto relativo.



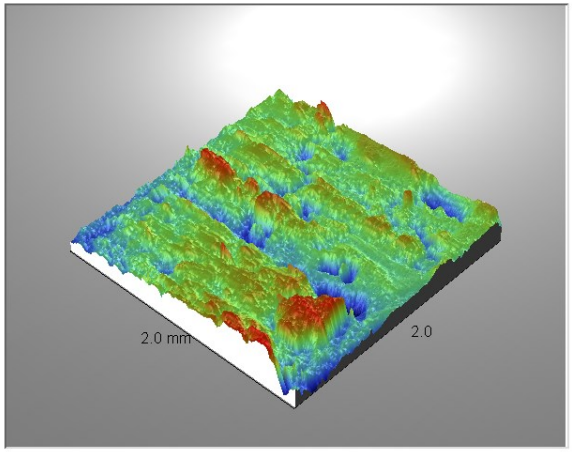


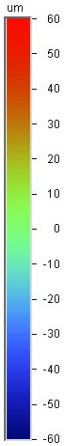






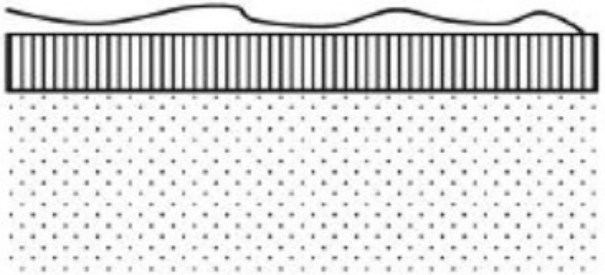
La superficie.

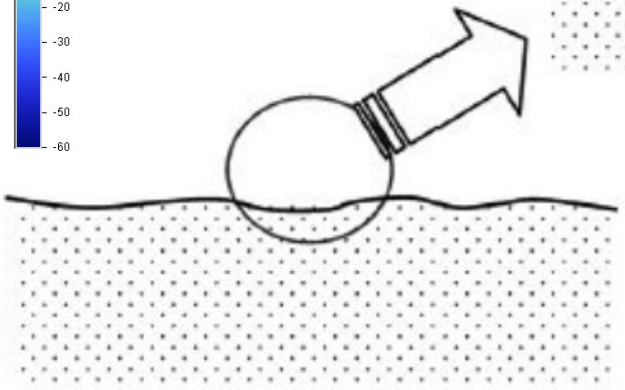




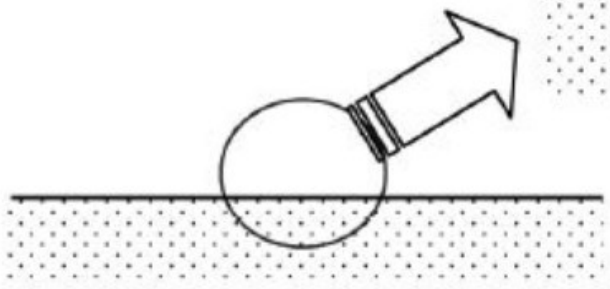
Contaminazioni, 0,3-3 nm

Strato di reazione
10-100 nm



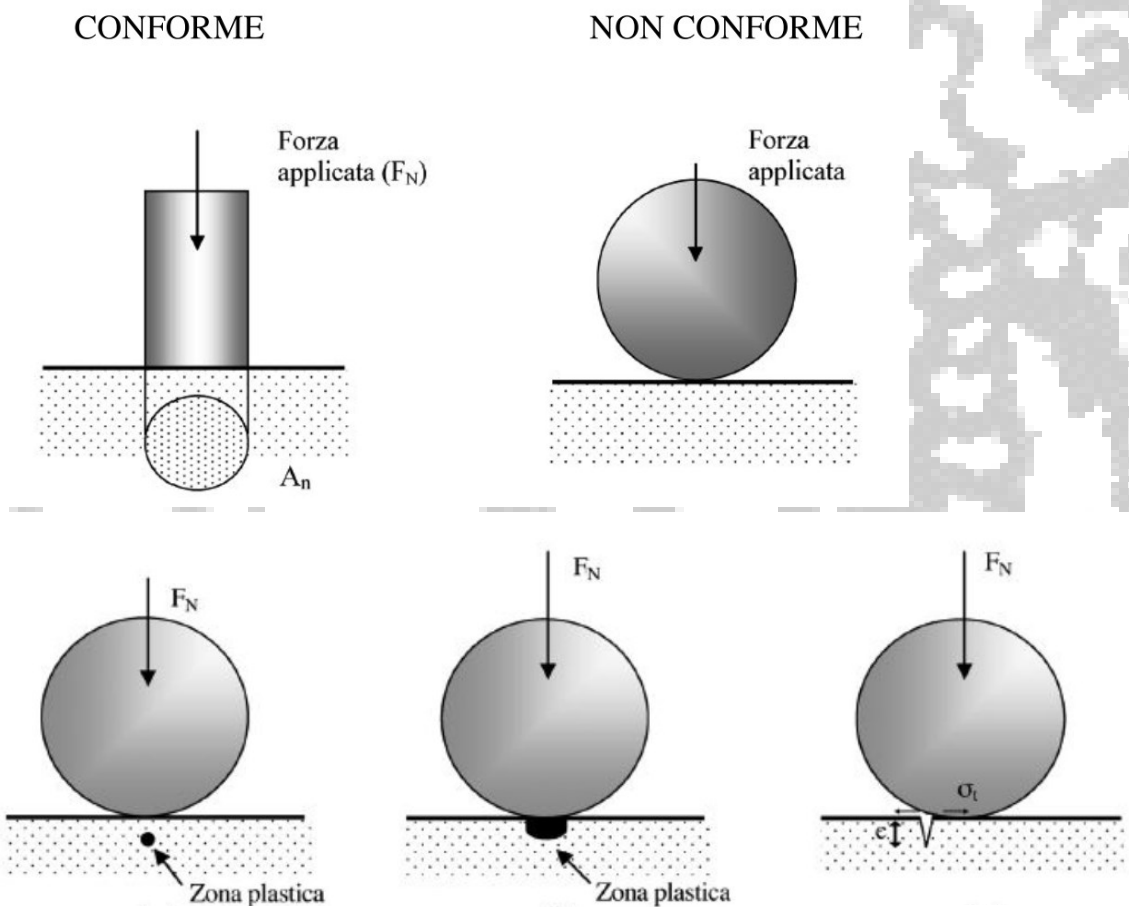


0,1-5 µm
asperità e avvallamenti
strato superficiale deformato



Superficie liscia

Il contatto.



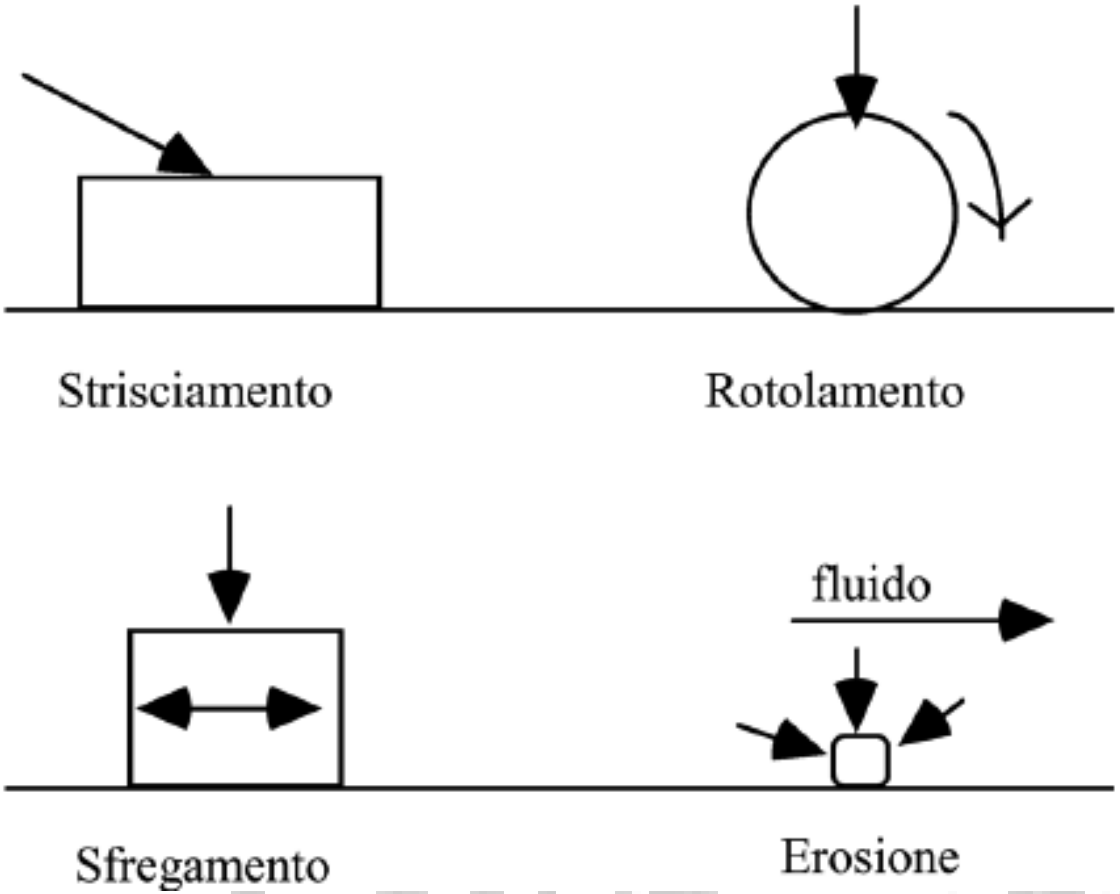
elastoplastico

plastico

fragile

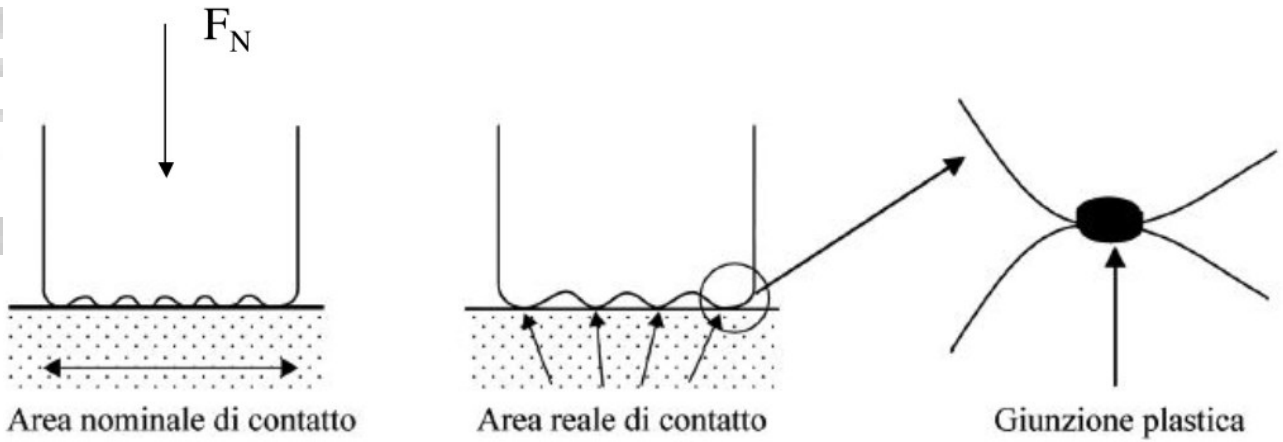
E' la fonte primaria del danneggiamento meccanico

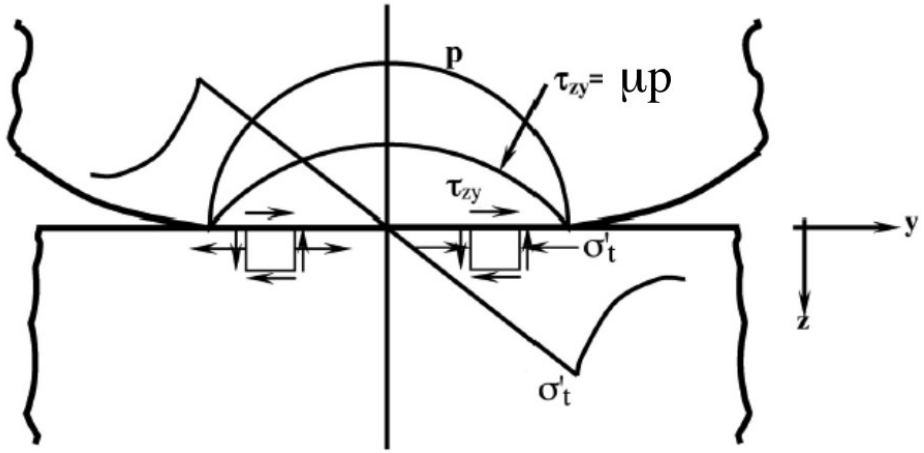
Il moto.



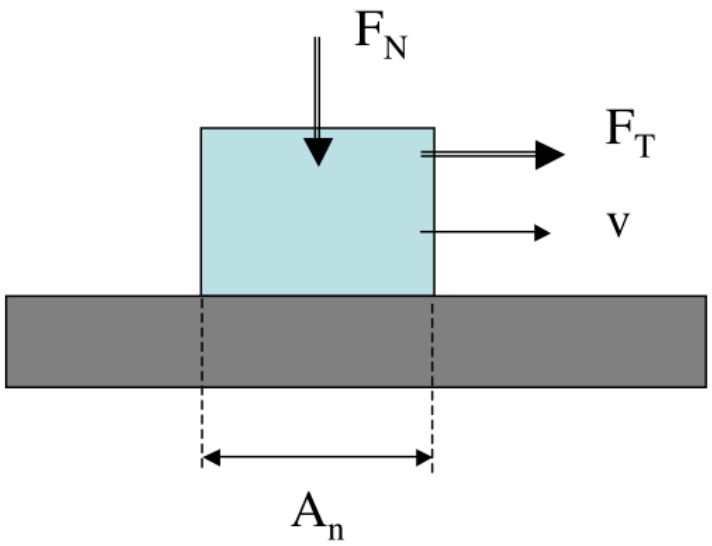
Possono essere anche combinati ed aggravati dall'ambiente più o meno aggressivo

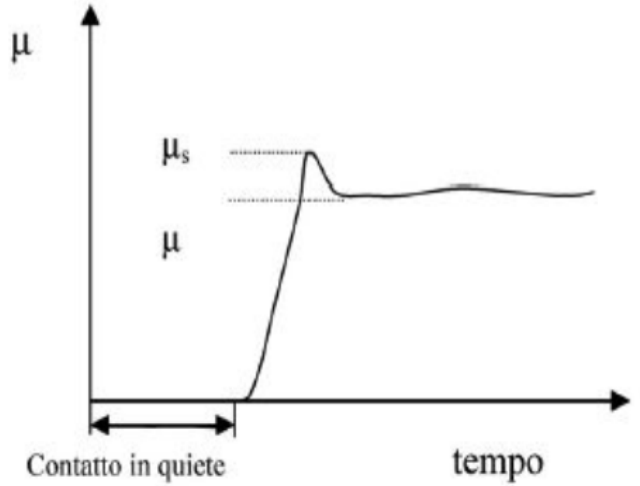
La combinazione dei fattori.





Attrito.





$$\mu = \frac{F_T}{F_N}$$

Potenza dissipata:

$$P = F_T\, v = \mu\, F_N\, v$$

Accorgimenti per ridurre Attrito.

- Utilizzo materiali di diversa origine (Es contatto metallo/polimero);
- Utilizzo di materiali incompatibili;
- Utilizzo di rivestimenti duri (alto spessore) o teneri (basso spessore);
- Utilizzo di lubrificanti;
- Ridurre I carichi in gioco
- Etc.....

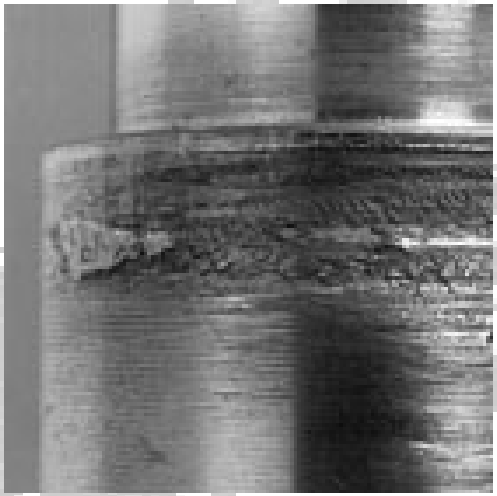
Usura.

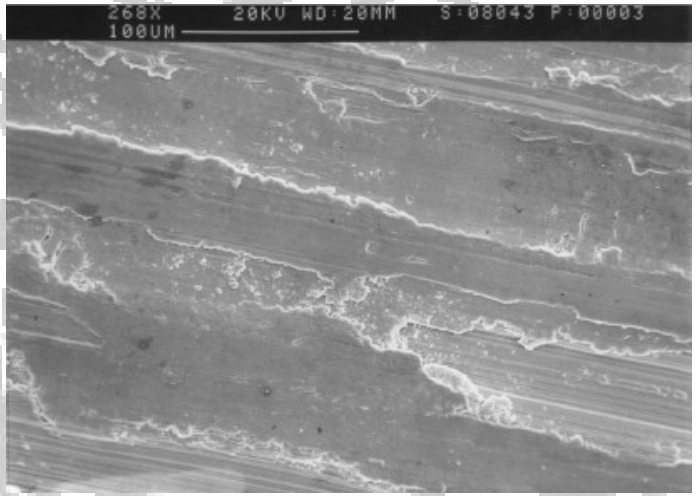
E’ la perdita di volume/materiale associata ad una sollecitazione tribologica (Hertziana).

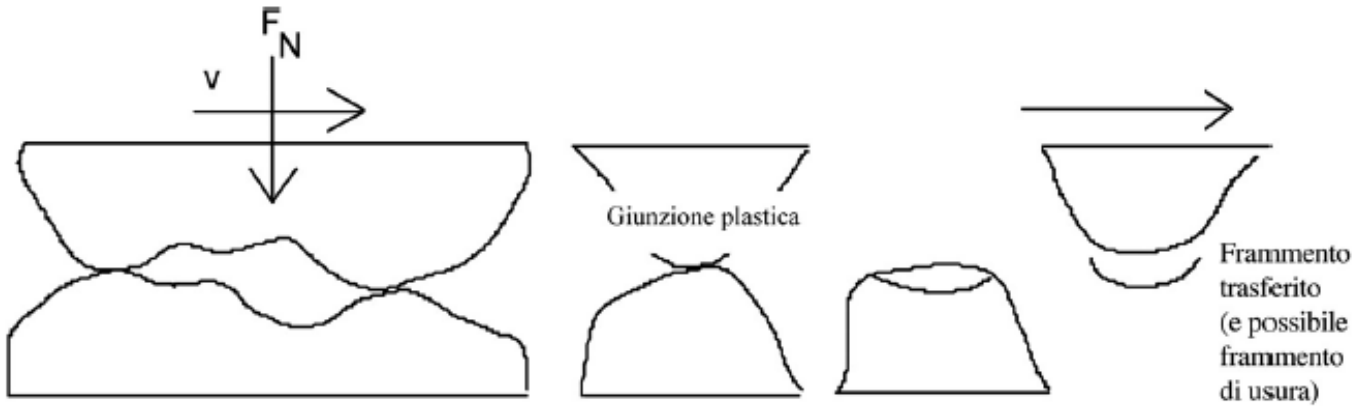
I meccanismi sono principalmente 4:

- Usura adesiva;
- Usura tribossidativa;
- Usura abrasiva;
- Fatica superficiale;

Usura adesiva.

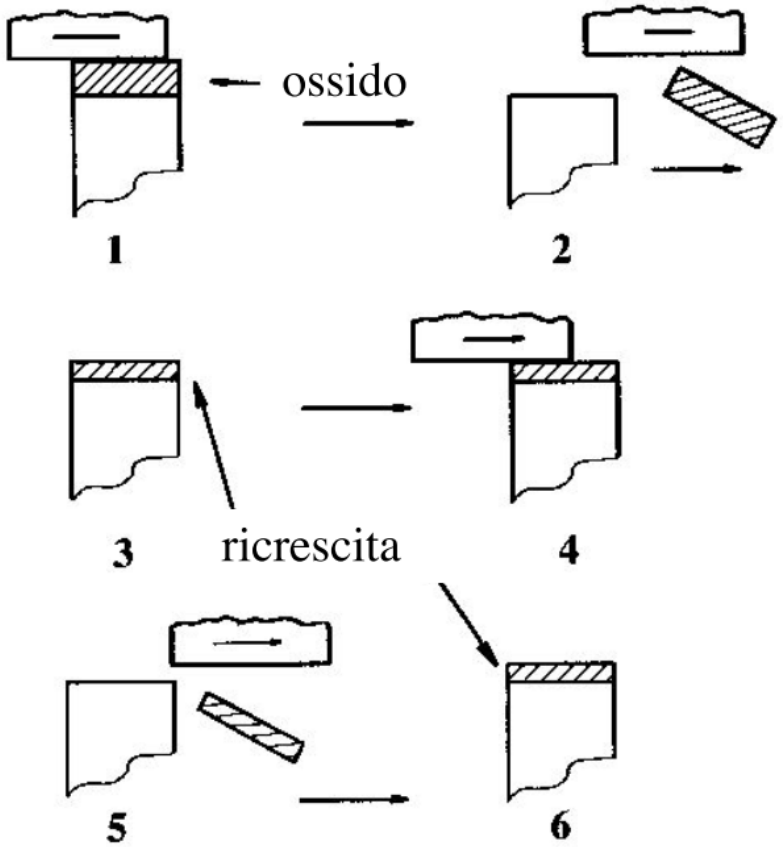




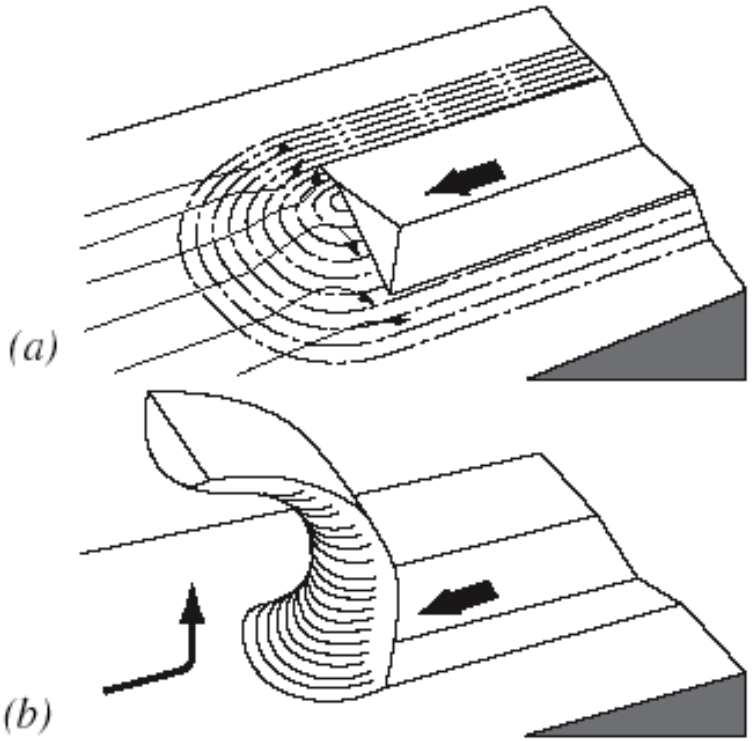


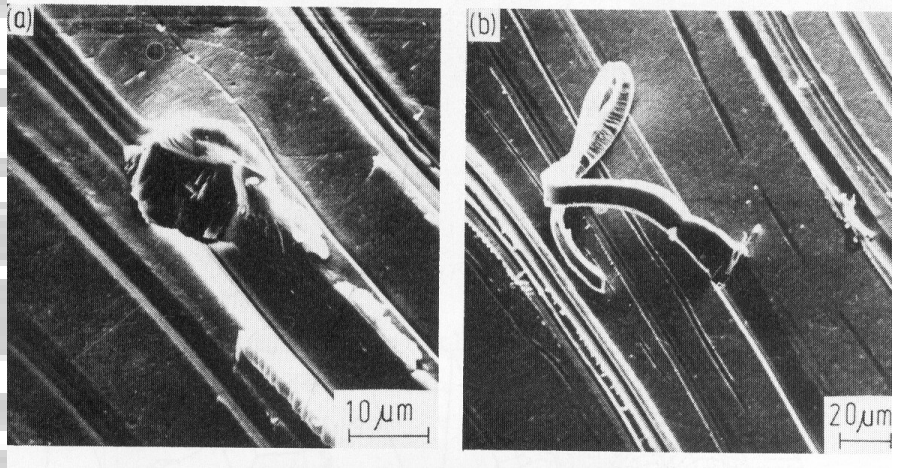
Usura tribossidativa.

$$q_w = \mu F_N v$$



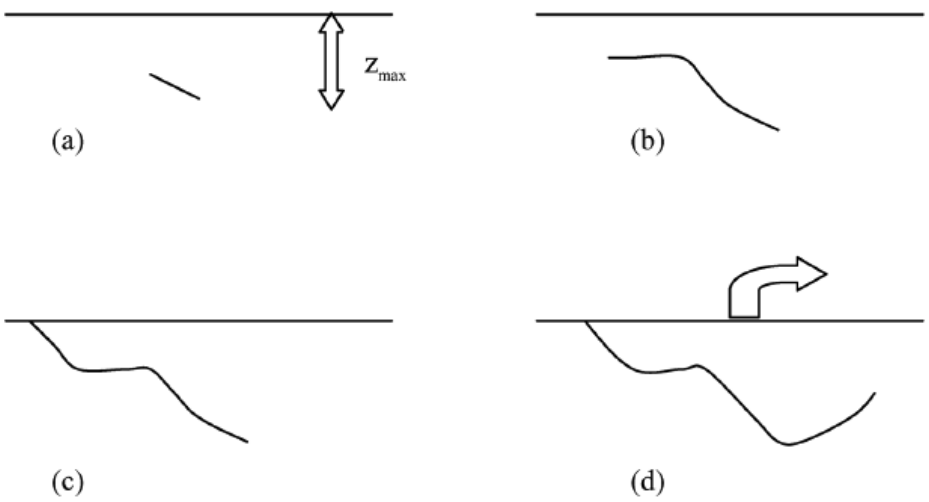
Usura abrasiva.

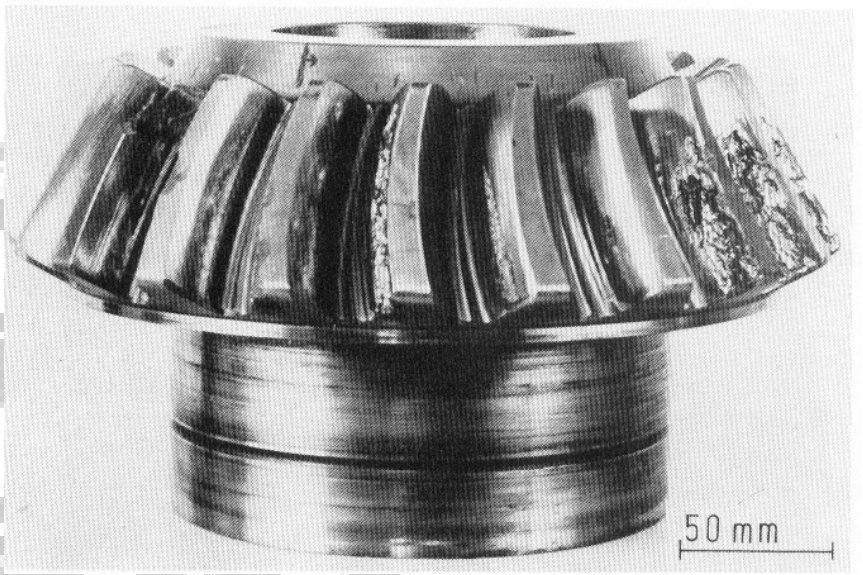


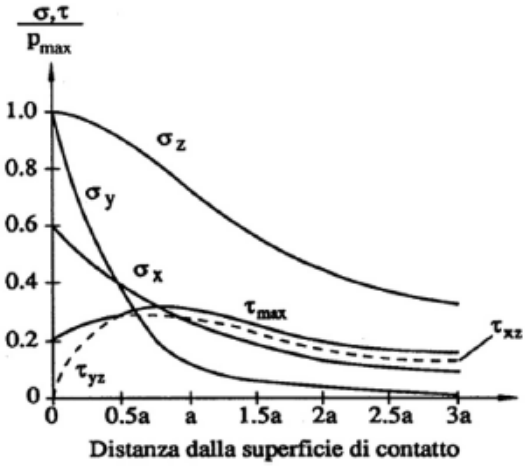


Durezza abradente =
Min(1,3 x materiale abraso)

Fatica superficiale.







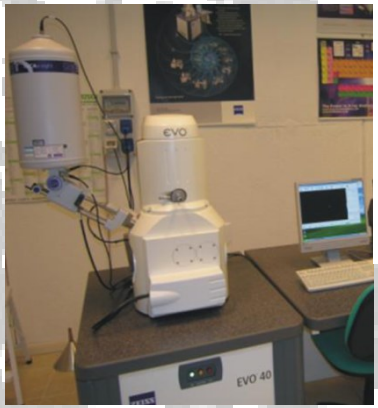
Accorgimenti per ridurre l'usura.

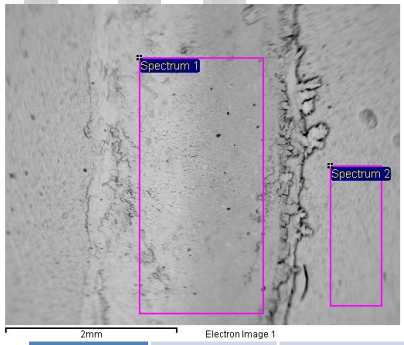
- Evitare l'utilizzo di materiali compatibili (Es: acciaio su acciaio);
- Utilizzo favorevolmente di materiali che si tribossidano;
- Utilizzo di materiali/rivestimenti duri (con cautela);
- Utilizzo di trattamenti duplex (termochimici+rivestimento duro);
- Utilizzo materiali con bassa densità di difetti;
- Per la resistenza ad abrasione utilizzare materiali duri o teneri a seconda dell'angolo di impatto;
- Etc…

Metodi di Studio ed analisi tribologiche.

Danneggiamento

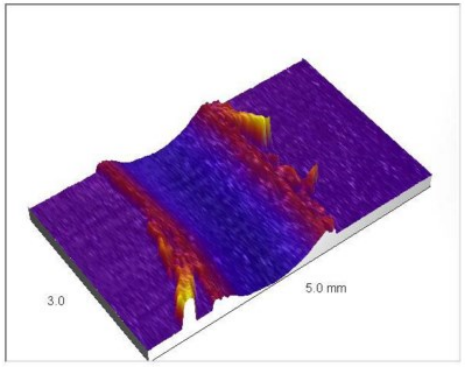
Det. meccanismo





Element	Weight%	Atomic%
Cr K	0.74	0.80
Fe K	99.26	99.20
Totals	100.00	

Det. Tasso usura



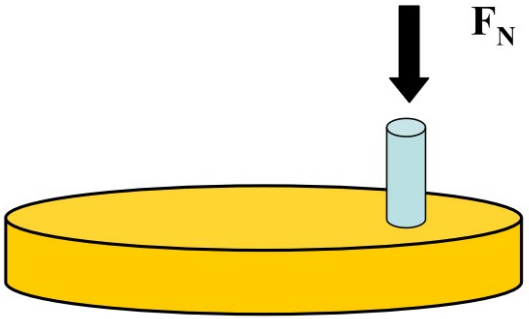
$$K1 = \frac{V}{F_N \cdot s} [mm^3 / Nm]$$

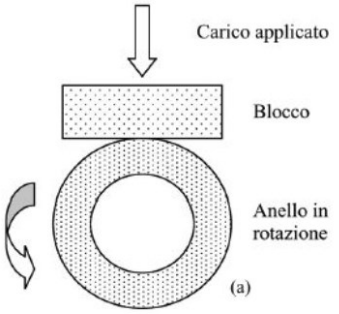
Strumentazione di friuli Innovazione

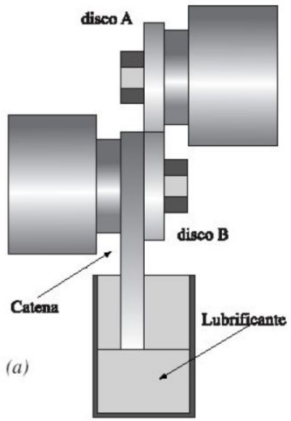
Metodi di Studio ed analisi tribologiche.

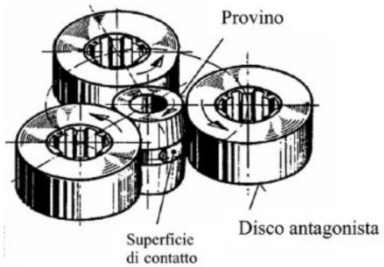
I test più comuni sono:

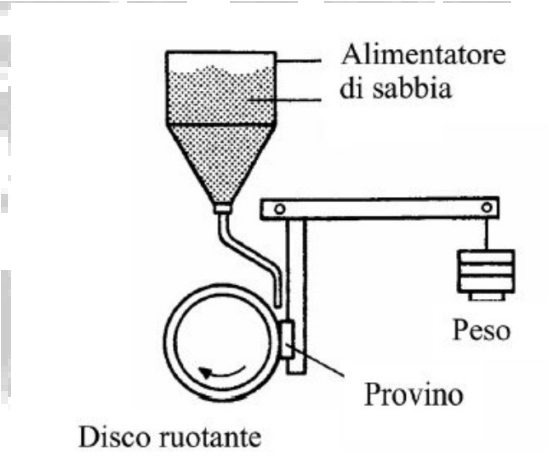
- Pin/ball on disc;
- Blocco contro anello;
- Disco contro disco;
- Dry-sand, rubber wheel test;

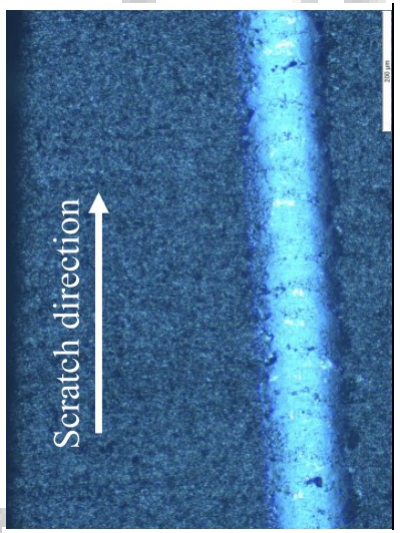












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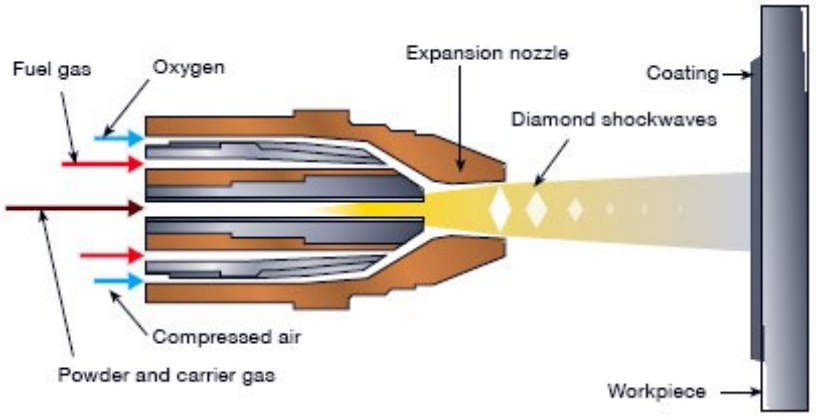
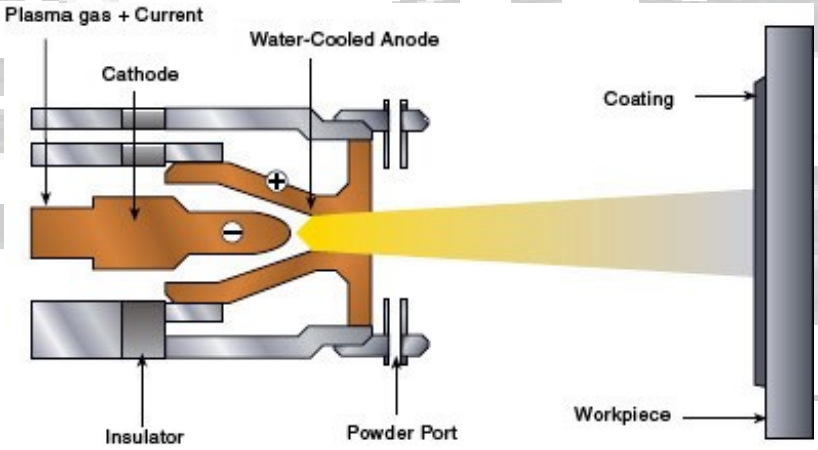
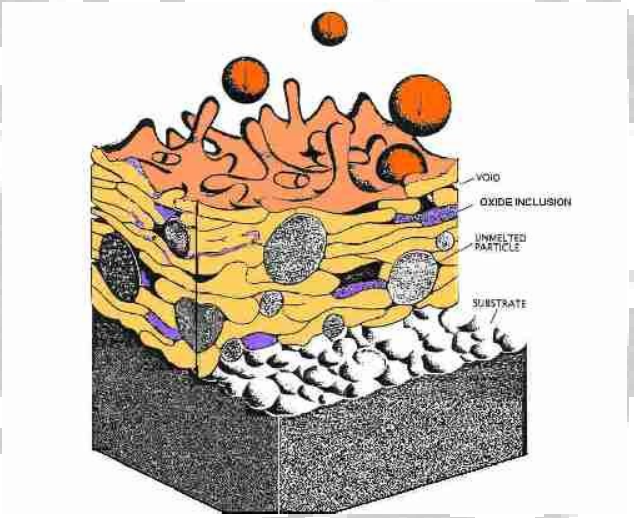
Esempio di ricerca sui rivestimenti thermal spray.

HVOF



APS





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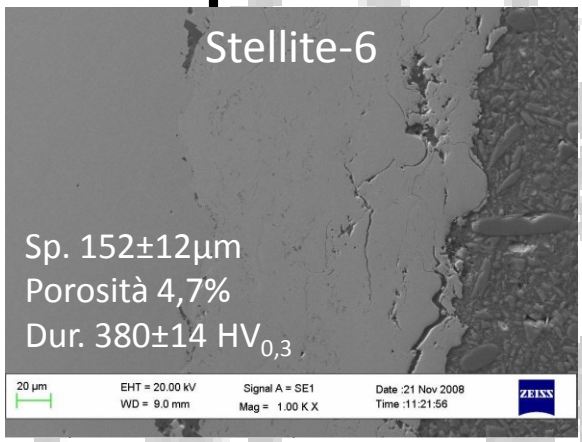

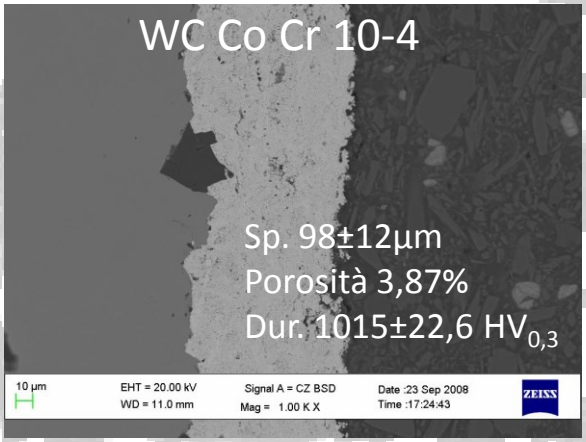

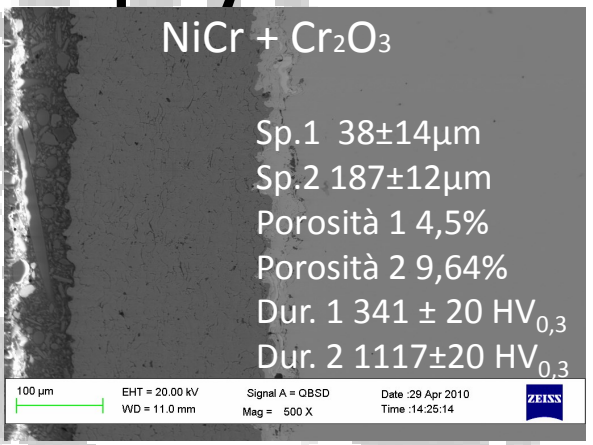

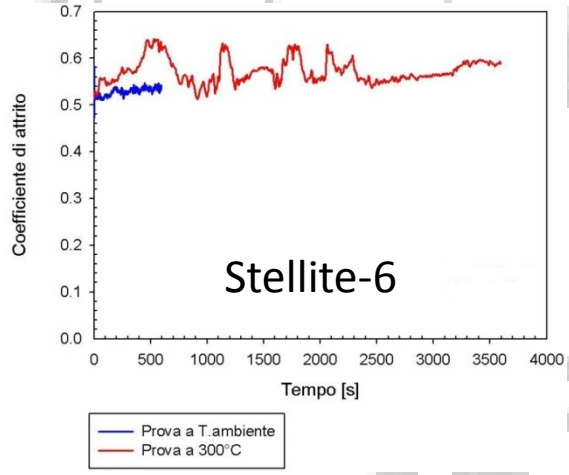

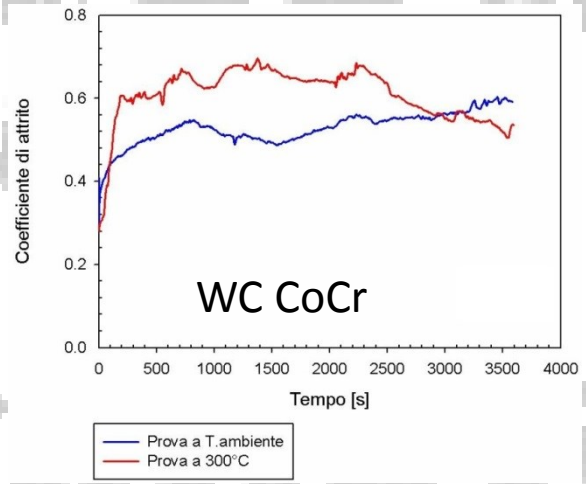

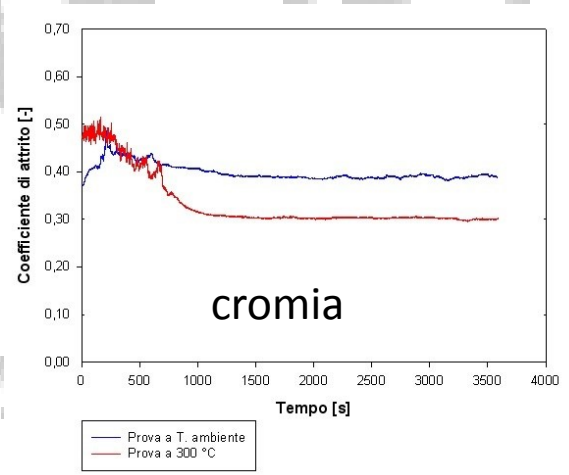

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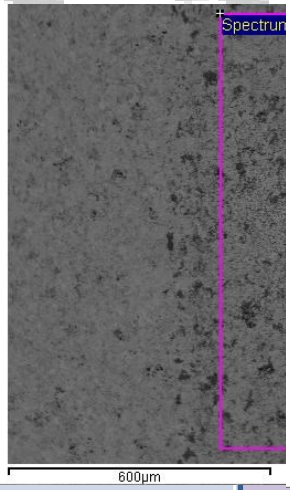
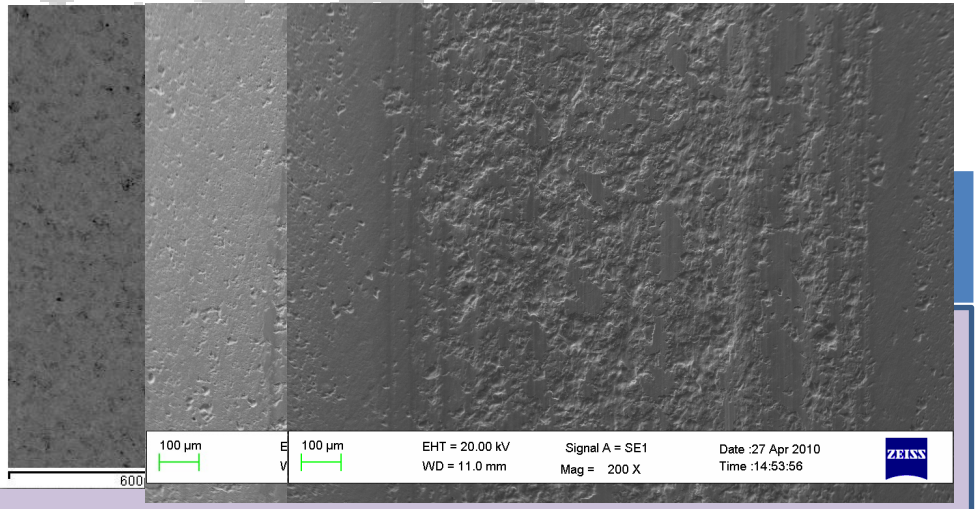
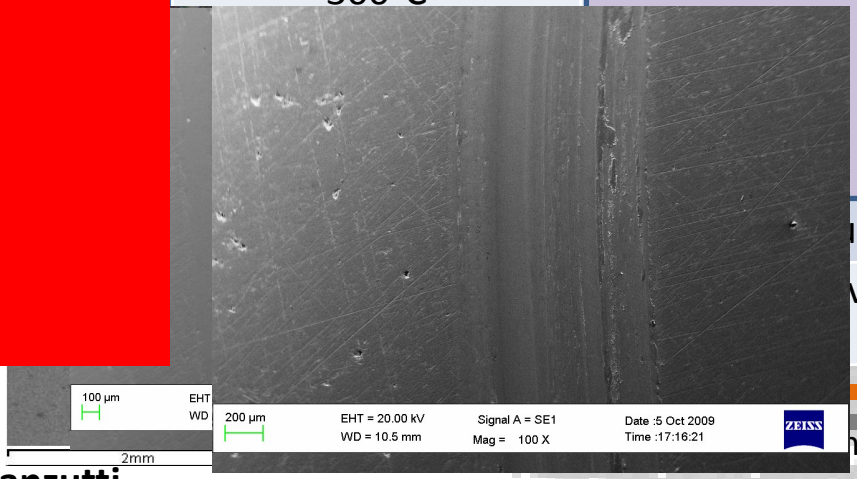
Esempio di ricerc





Rivestimento	Condiz
	T ar
	T ambiente
	300°C
	T ambiente
	300°C

Usura tribossidativa più o meno intensa con usura da terzo corpo.



ura rivestimento, usura da terzo corpo

vestimento molto intensa e infragilimento causa cambio fase[1]

nn, O.K. Kwon, *Wear*, 225-229 (1999), 814-824;

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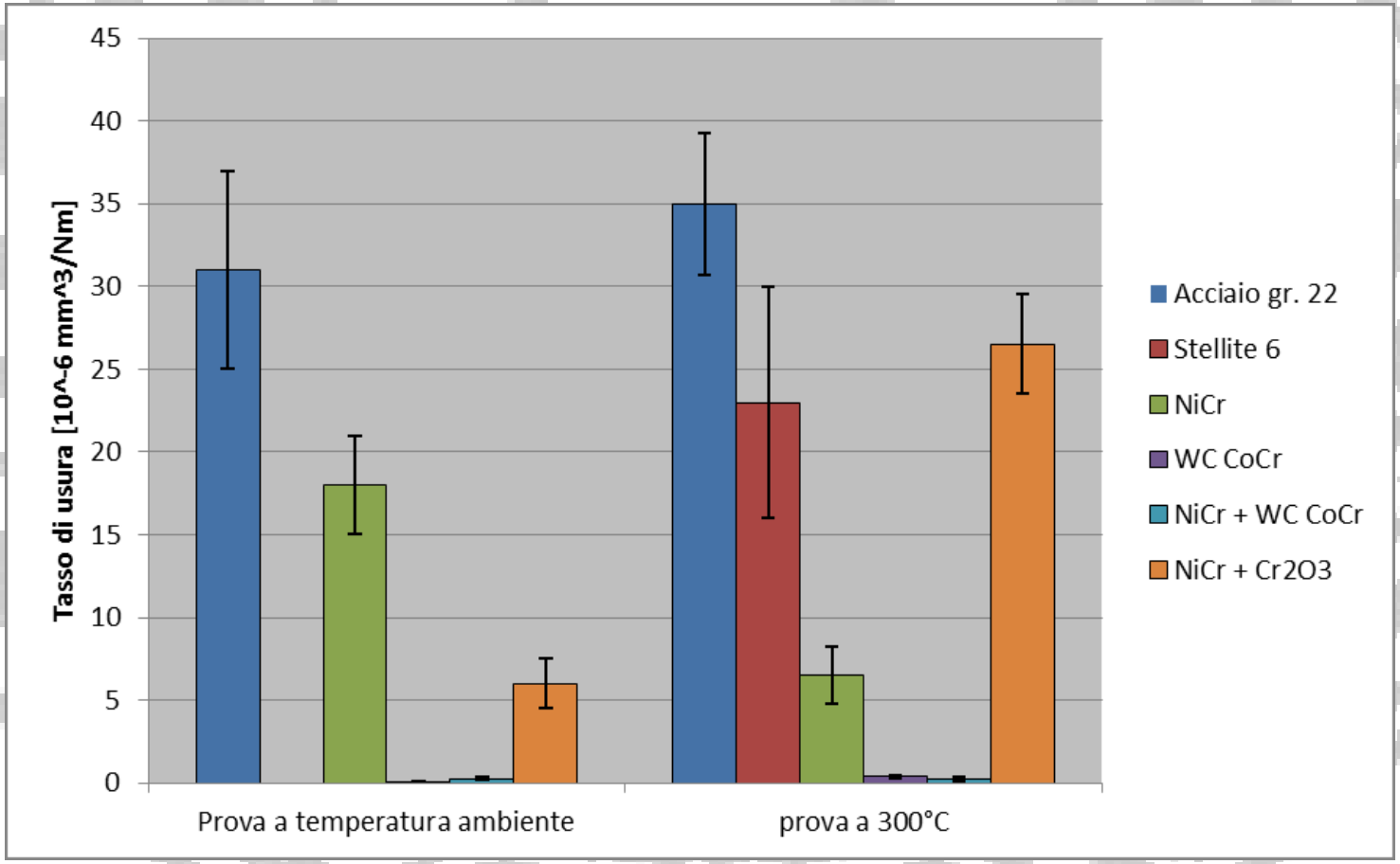
Esempio di ricerca sui rivestimenti thermal spray.



Bibliografia

- Dispense corso tribologia AIM 2010;
- G.Straffelini, Attrito ed usura;
- ASTM metal handbook;
- Tesi Dr Alex Lanzutti
- Varie fonti in rete

Grazie per l'attenzione!!!!!!!

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