

Nanostructured Self-Healing Surface Films

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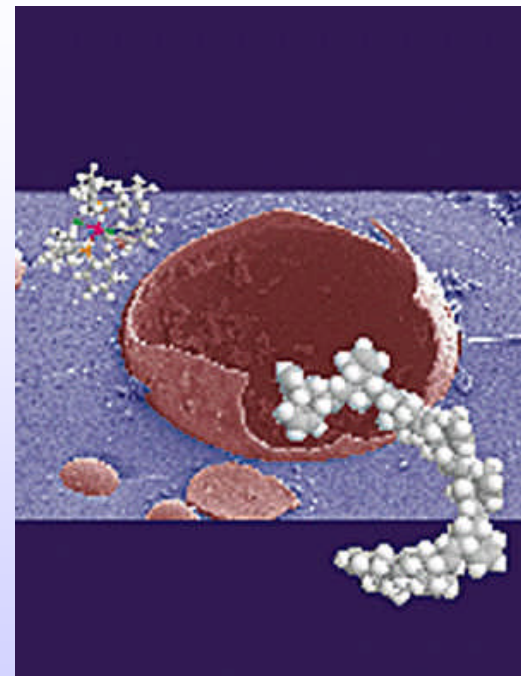


The Healing Power of Materials

- Plastics
- Metals
- Concrete
- Paint

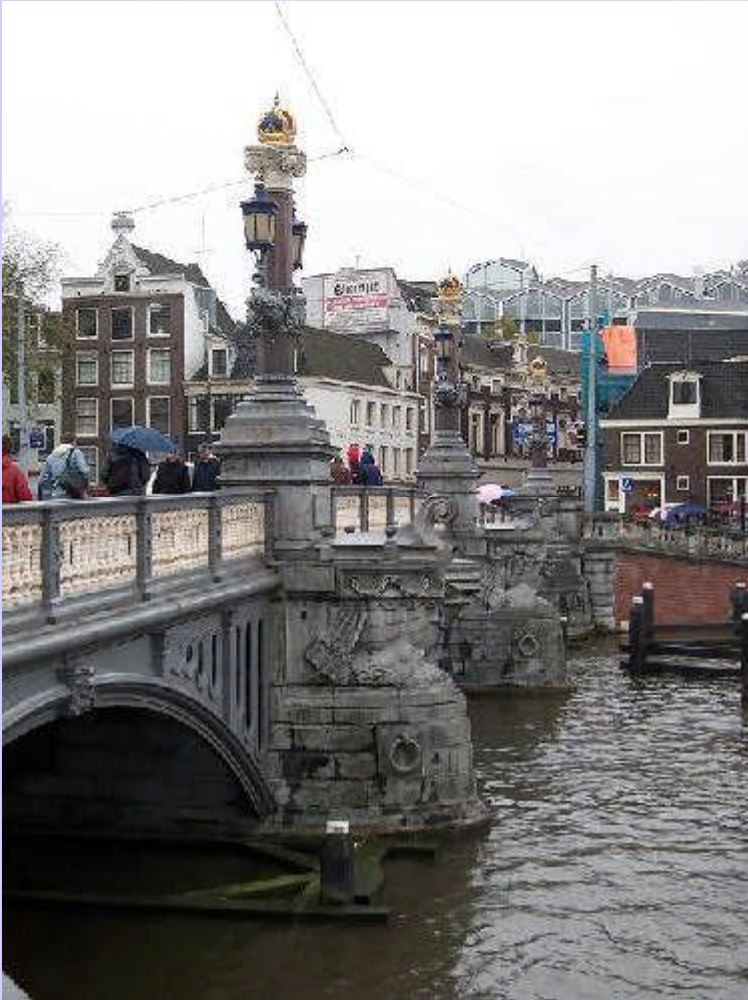


Polymers



White et al., Nature, 2001.

Concrete



Blauwe Brug, 1884.

Paint



Nissan' self healing coating.

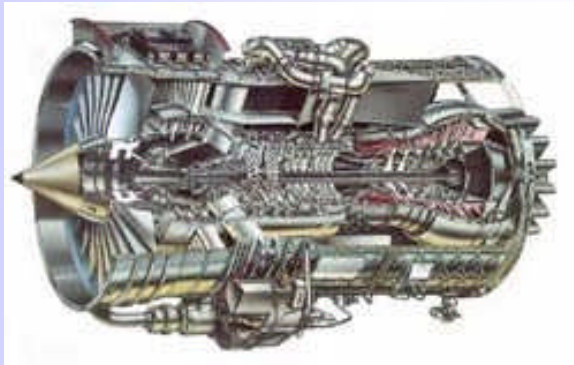
Self Healing Metals

Nature's Role:

the more stable a metal is,
the longer it lasts.

Engineered Role:

Use less stable metals to
heal cracks and fatigue.



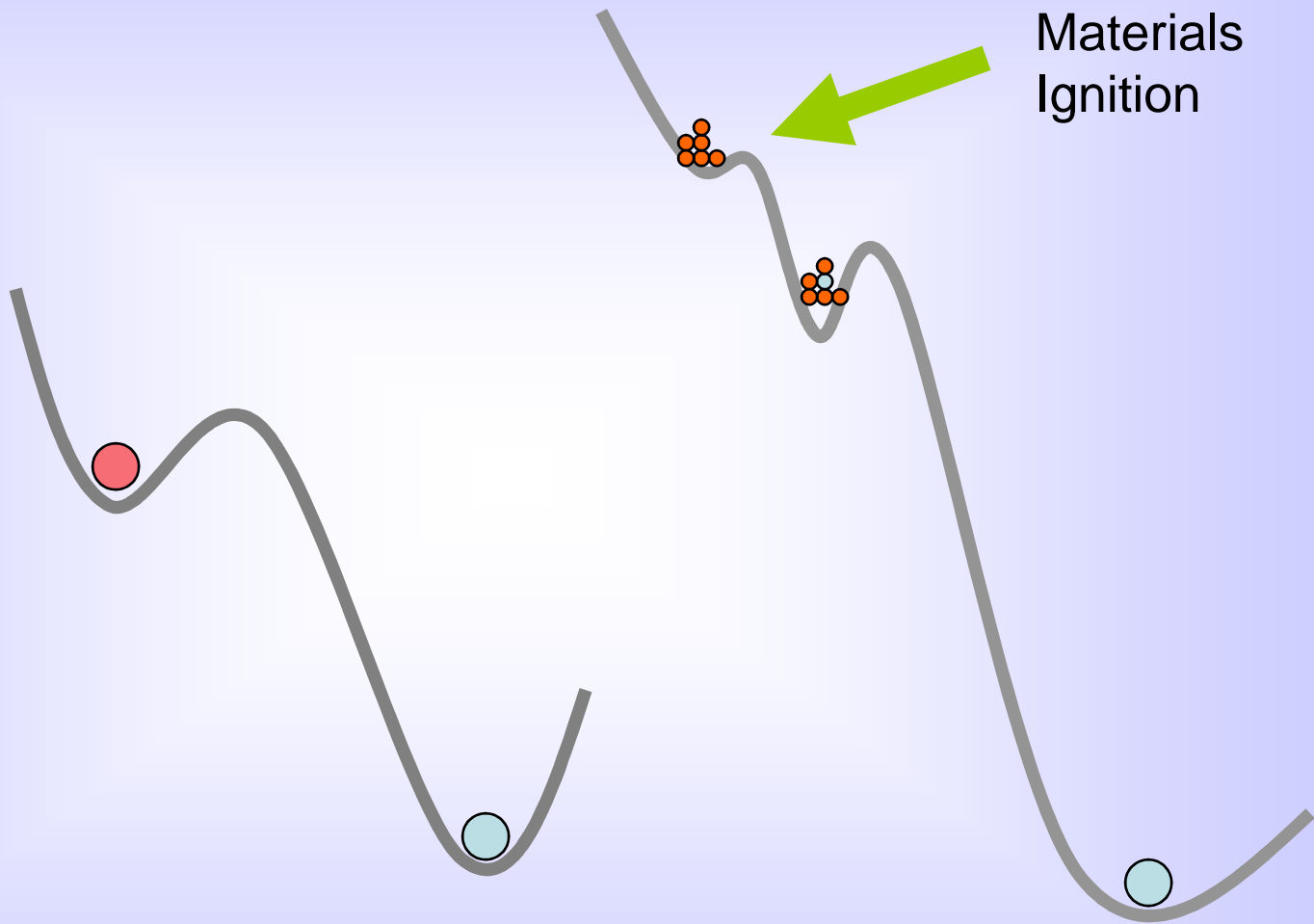
Al - Cu + Ag

CSIRO

Monash Univ.

Delft Univ. Tech.

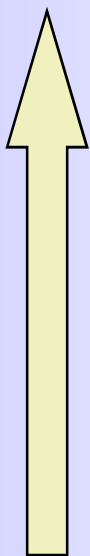
Energy ↑



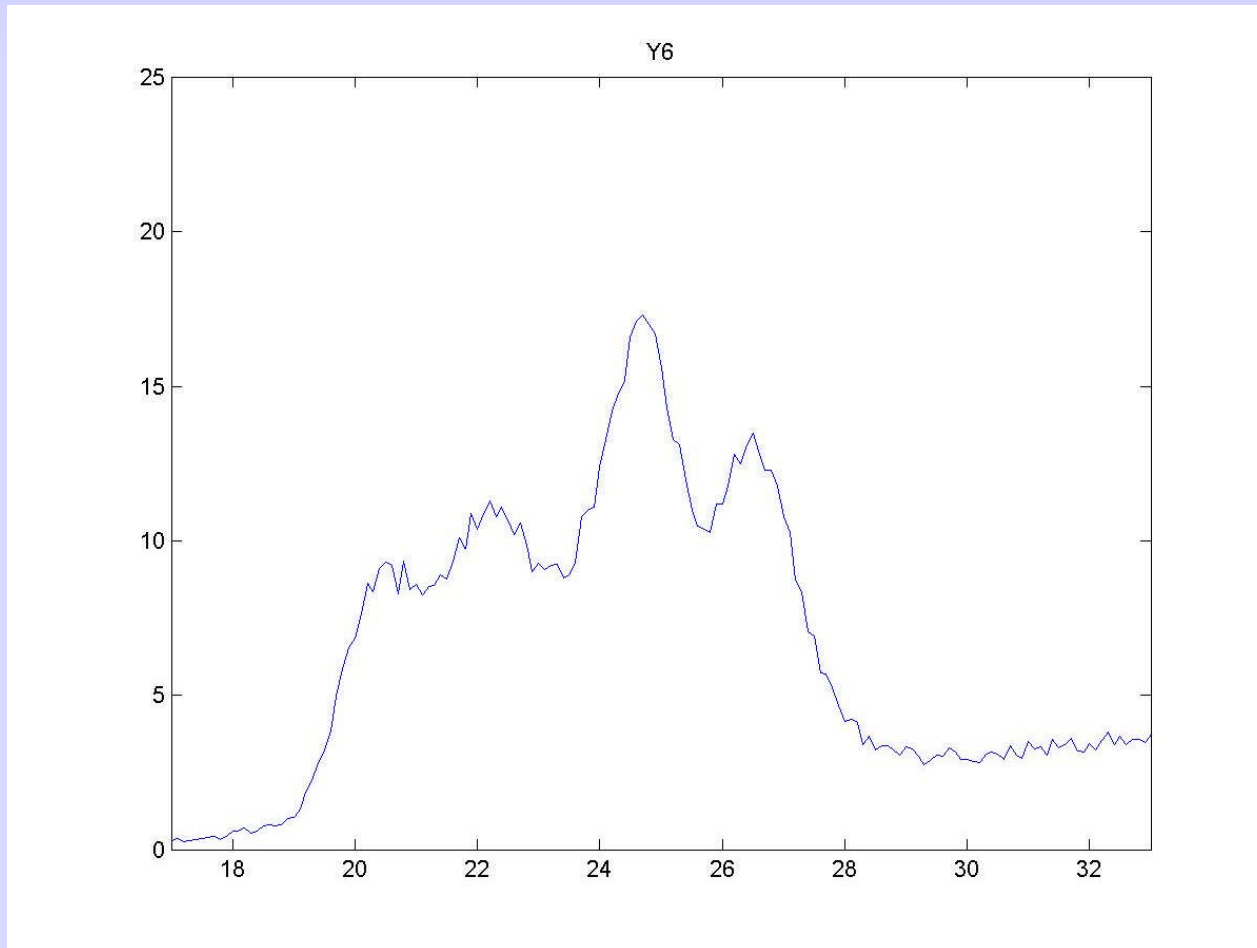
Regular

Engineered

Energy

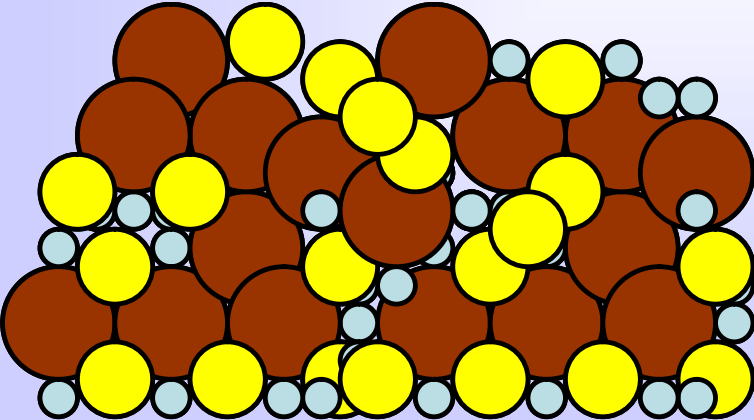
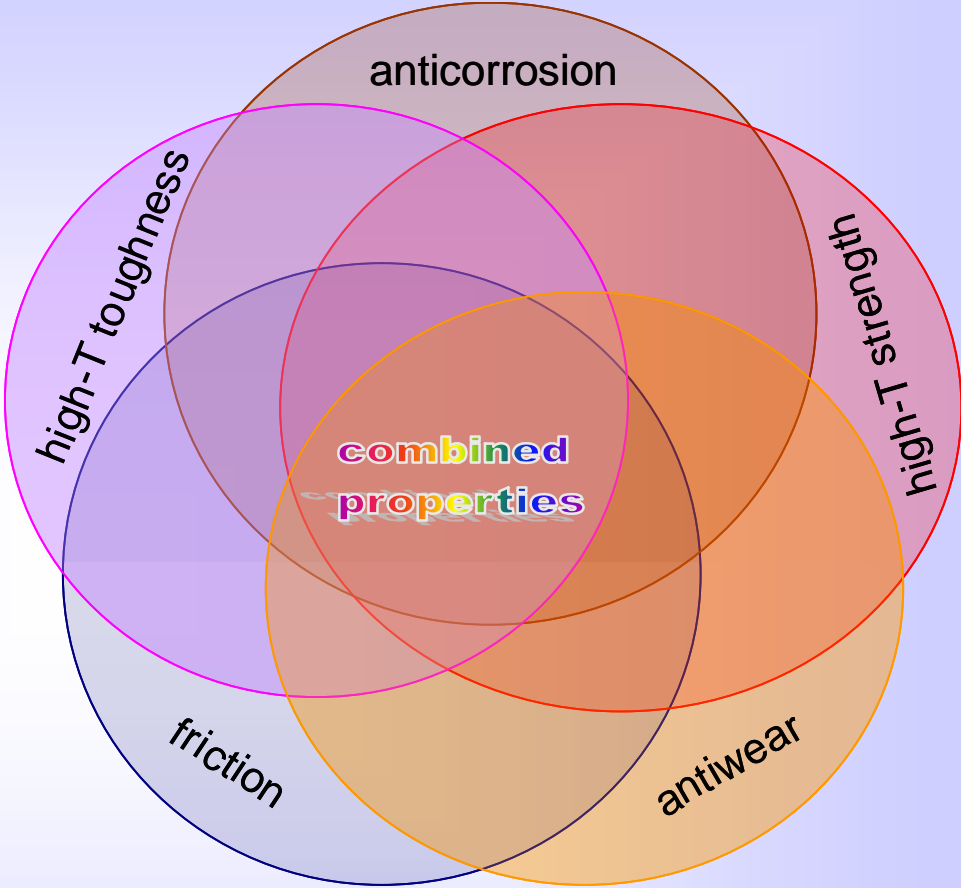


To increase the stability..

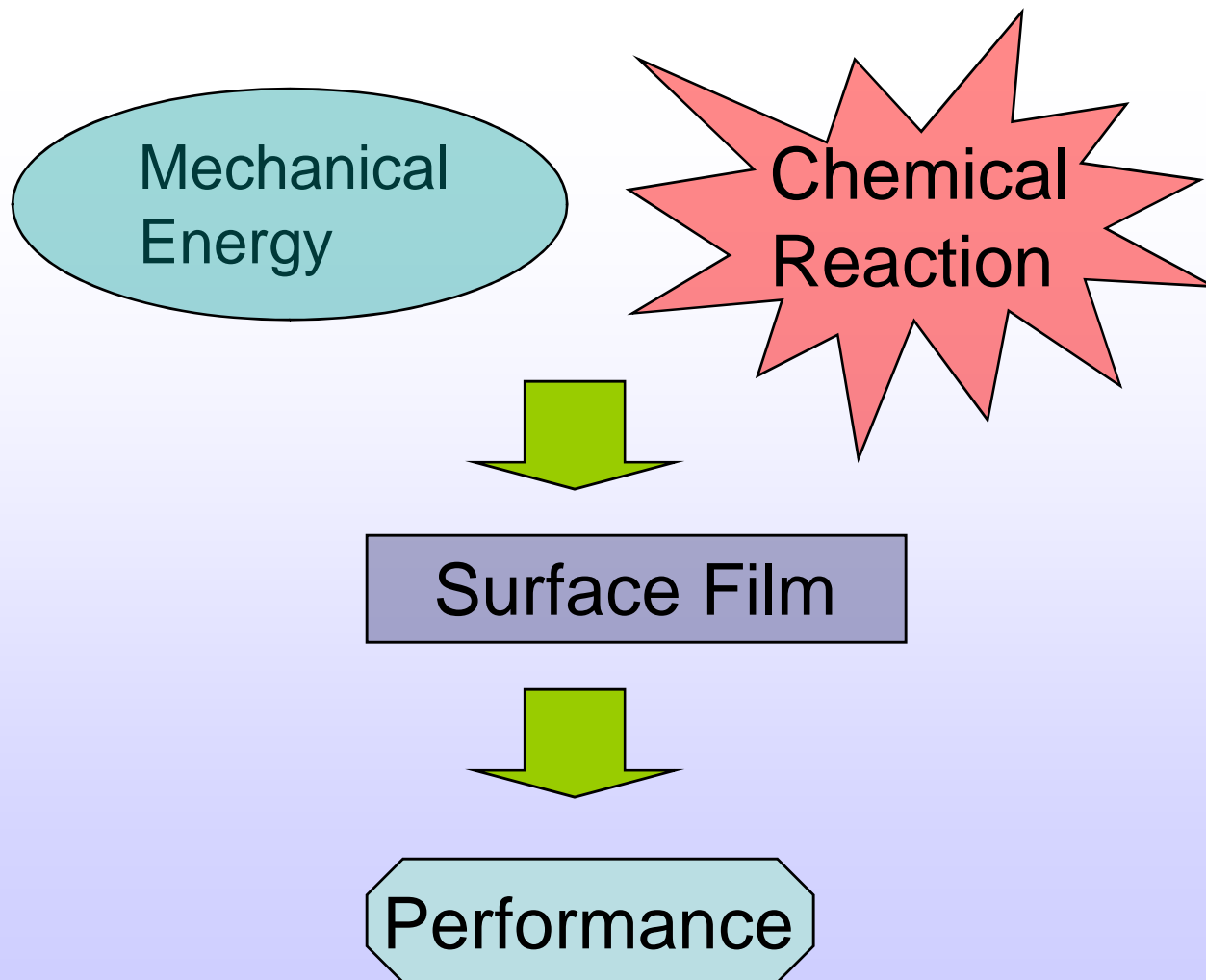


Materials are more active than we expected.

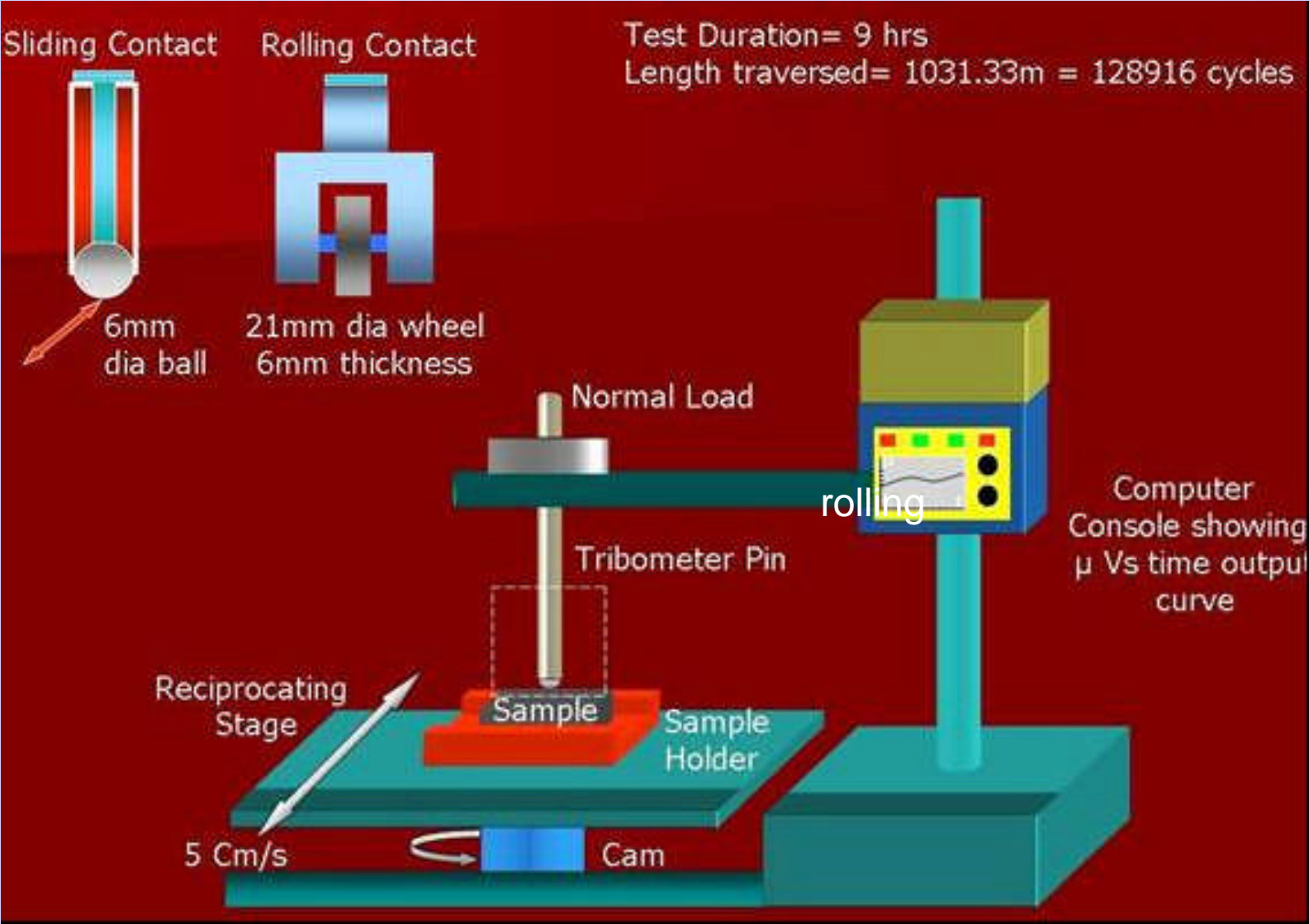
Goal



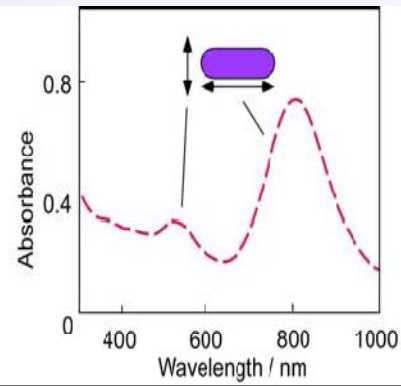
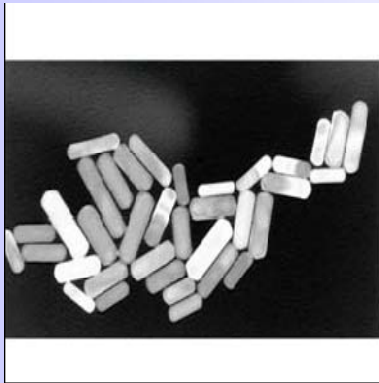
Approach



Experimental Setup



Materials:

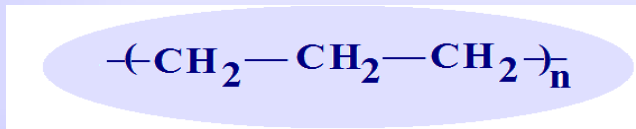


Periodic Table of the Elements

1	2																	10
3	4											5	6	7	8	9	10	
11	12											13	14	15	16	17	18	
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
55	56	*La	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
87	88	+Ac	104	105	106	107	108	109	110	111	112	113						

* Lanthanide Series	58	59	60	61	62	63	64	65	66	67	68	69	70	71
	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
+ Actinide Series	90	91	92	93	94	95	96	97	98	99	100	101	102	103
	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Vehicles:

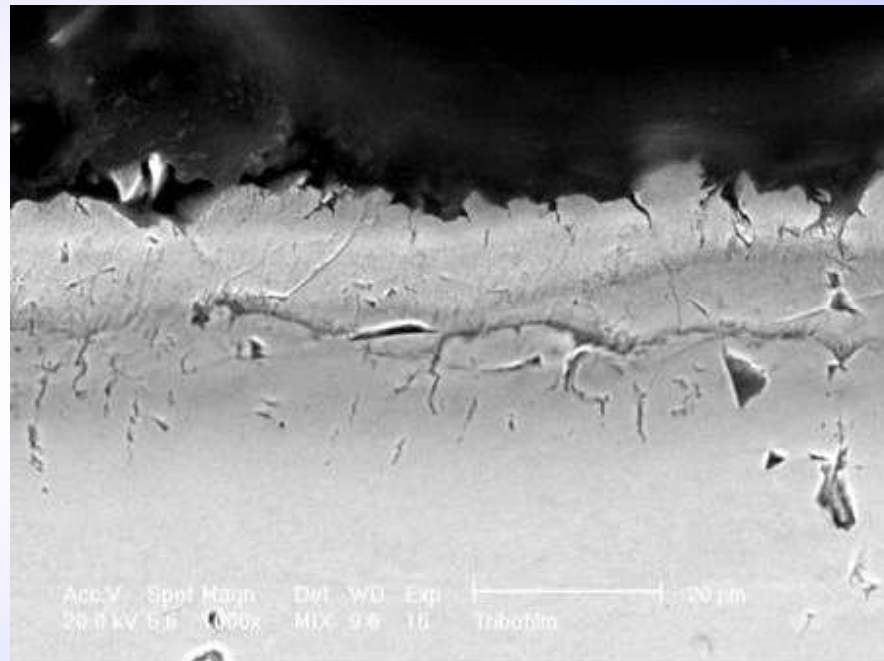
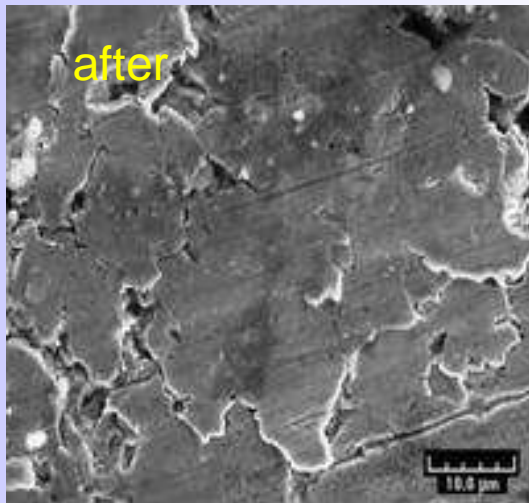
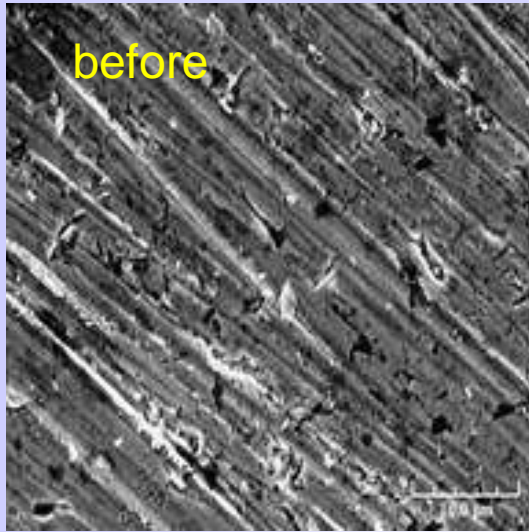


Mineral Oil Chemical Structure



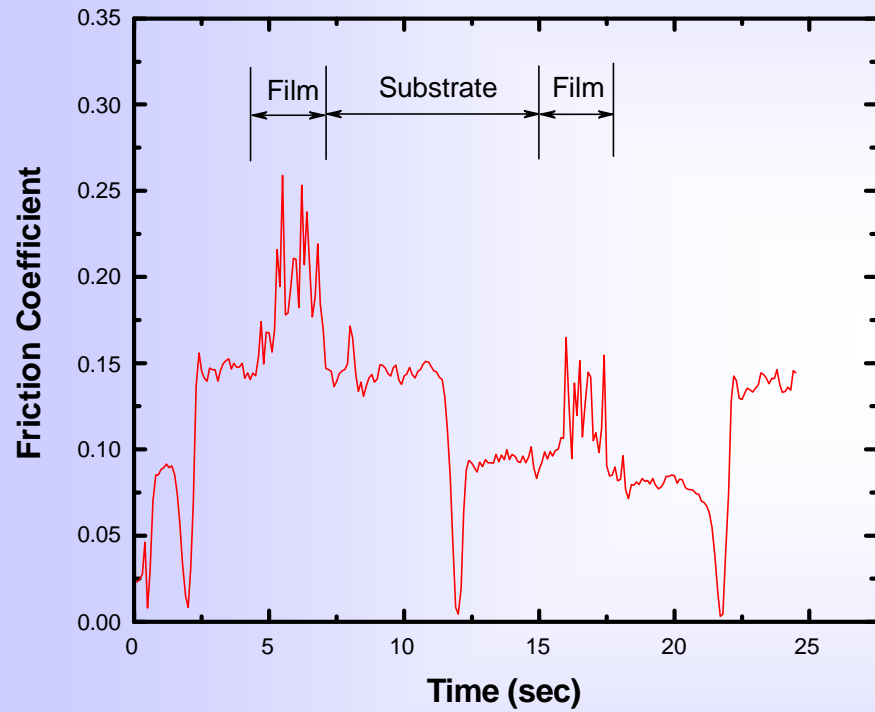
PEG Chemical Structure

Track Surface

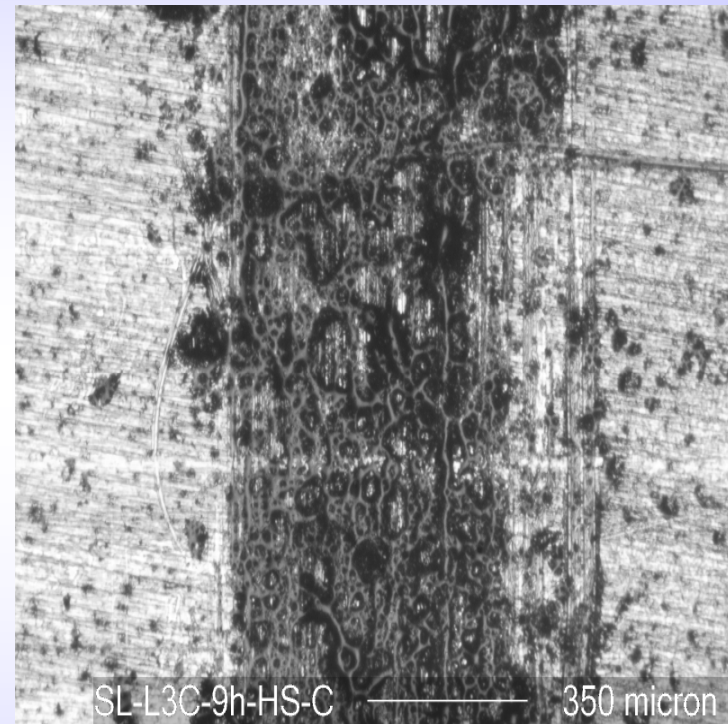


Cross Section

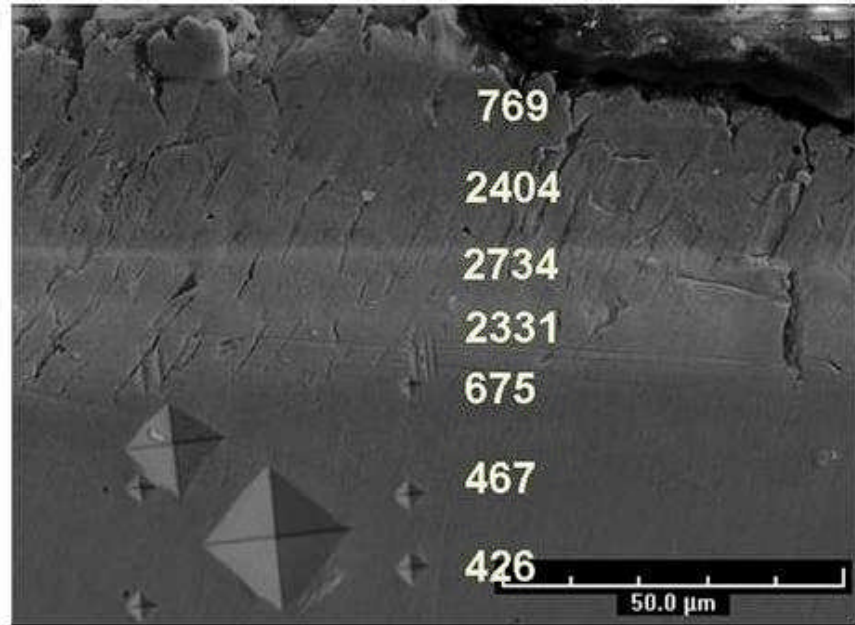
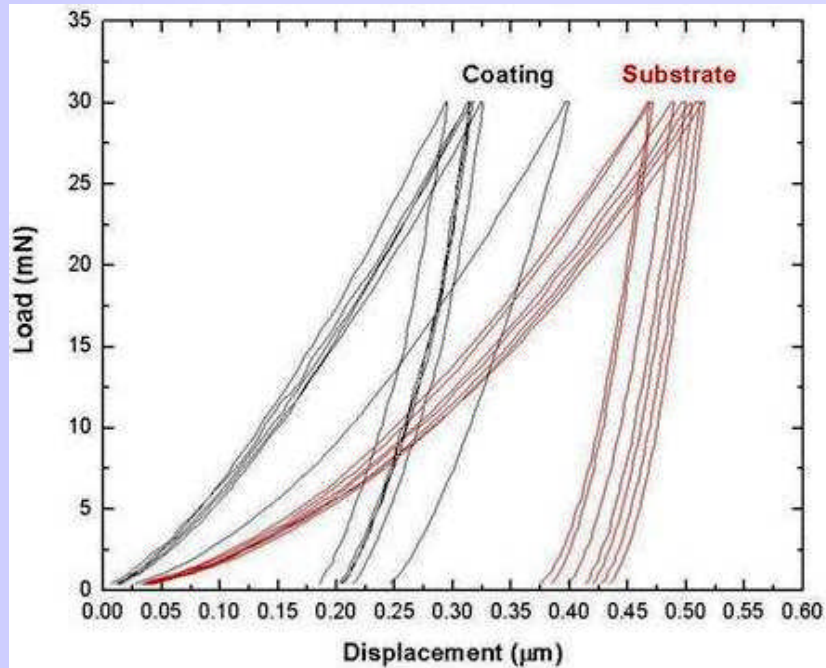
The film is wear resistant



Scratch tests

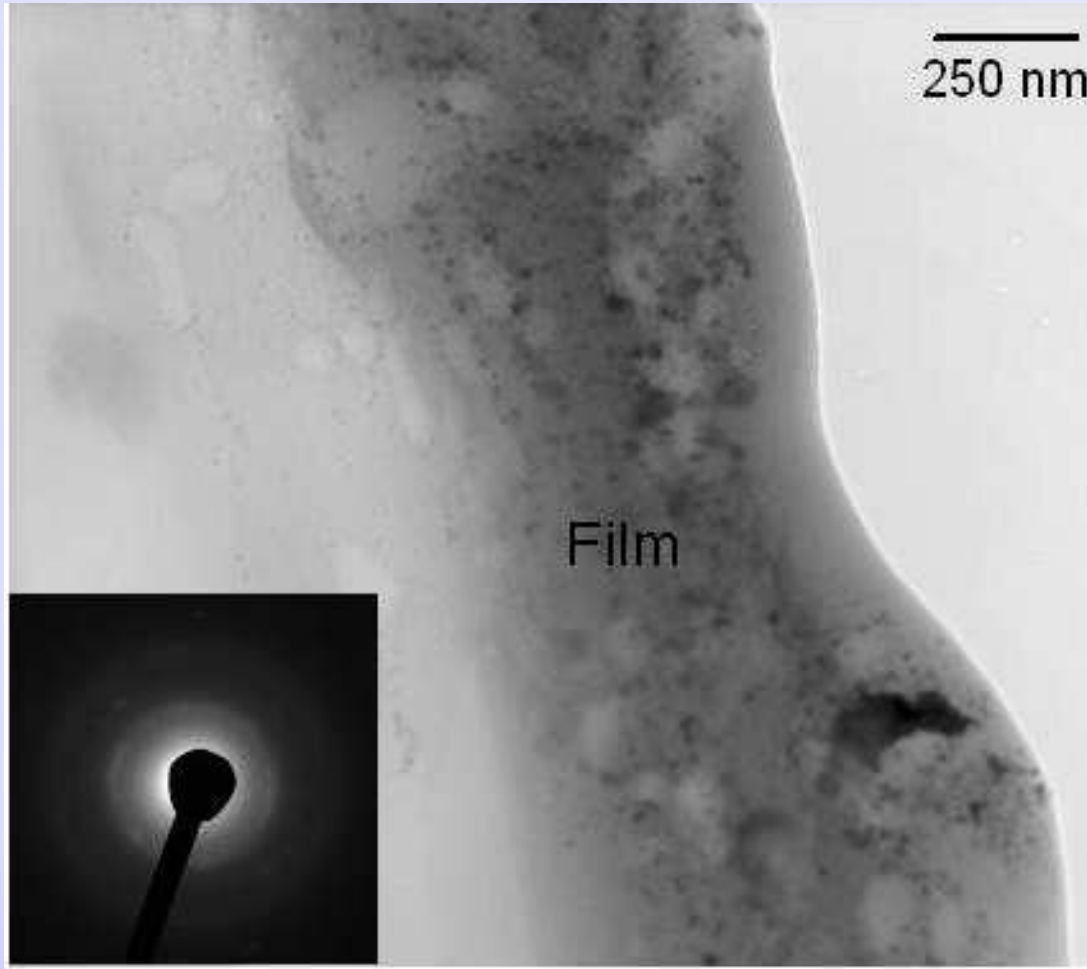


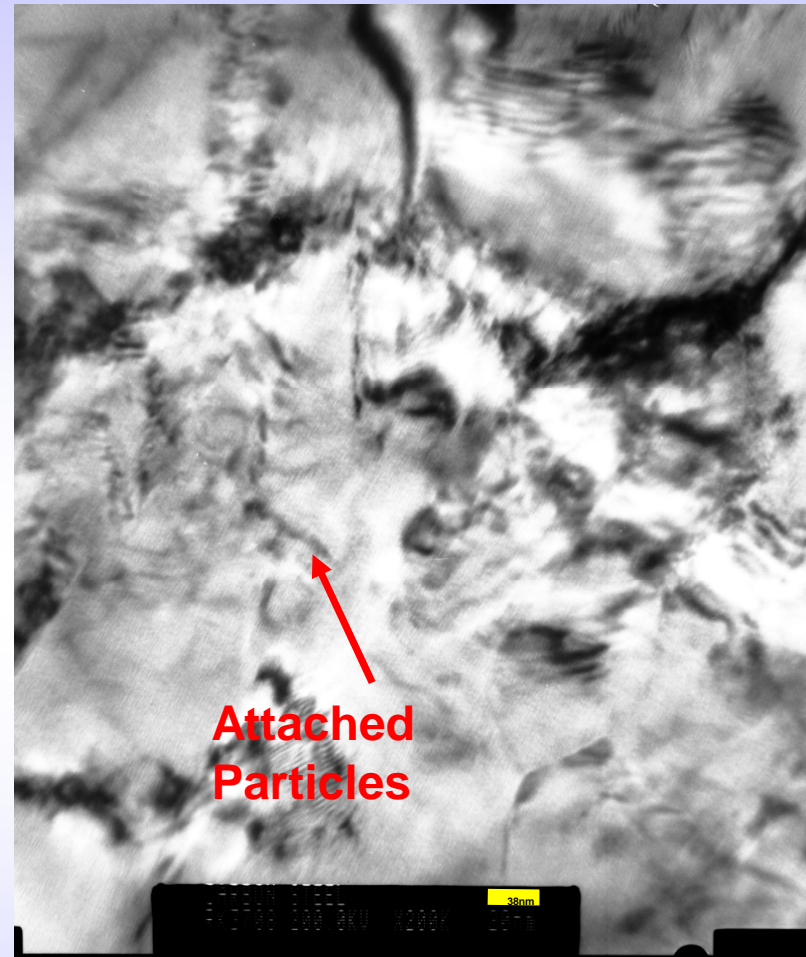
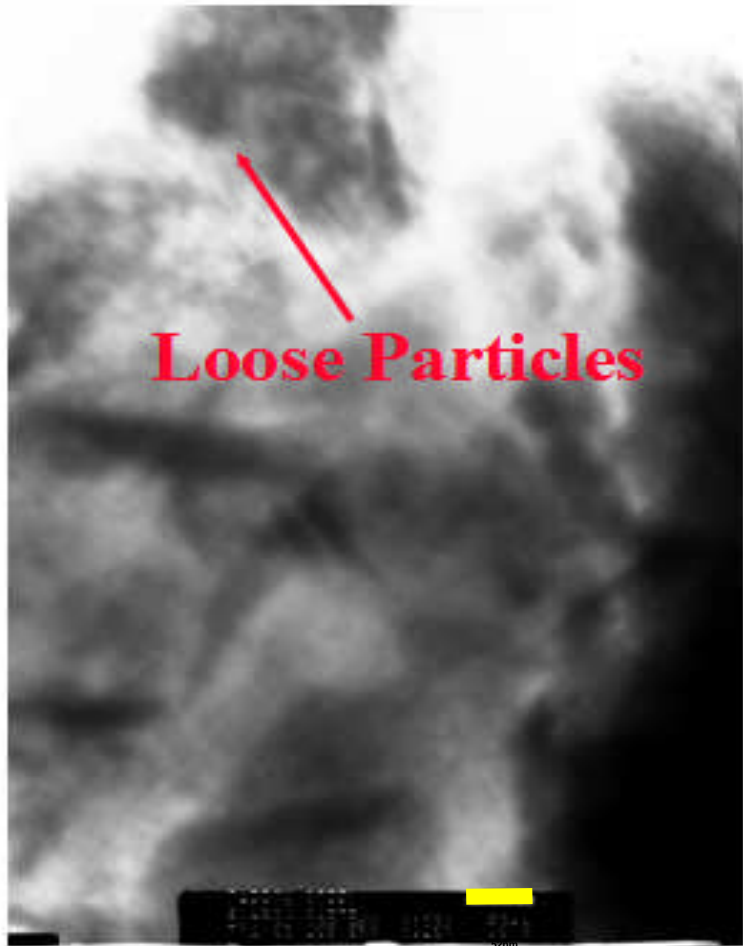
Wear tests



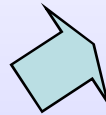
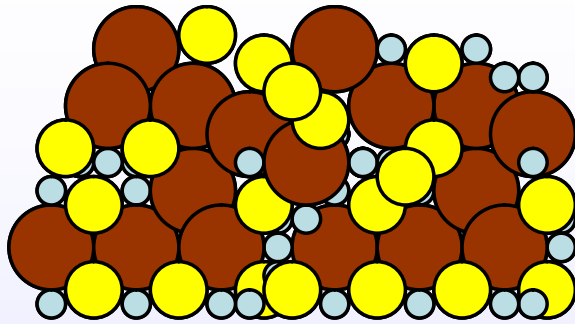
Microhardness of the film is more than five times of that of the substrate

The film is made of nanostructured/amorphous layer





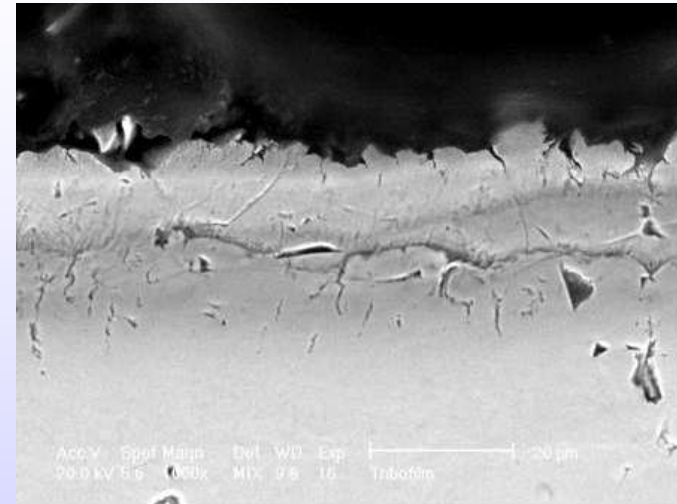
Summary



Periodic Table of the Elements

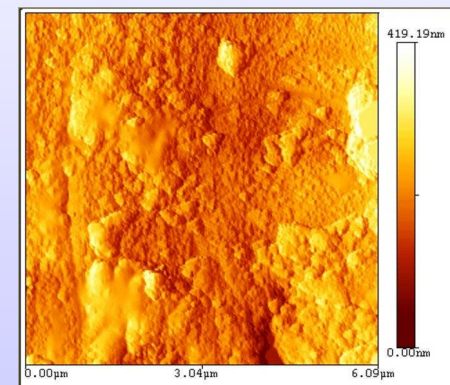
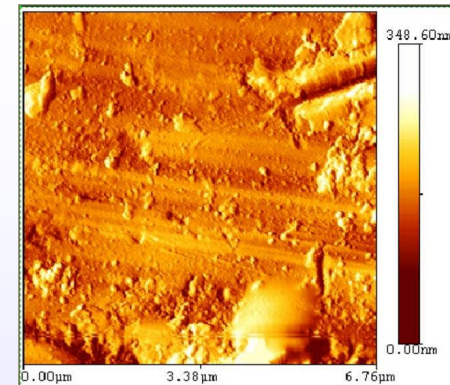
1 IA H																	2 IIA He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	*La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
87 Fr	88 Ra	+Ac	Rf	Ha	Sg	Ns	Hs	Mt	110	111	112	113					

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+ Actinide Series	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	



Summary

- Mechano-chemical process to form a surface film.
- Mechanical energy is highly controllable.
- The film can lubricate, self-repair, maintain, and extend materials' service life significantly.



AFM Micrographs.