

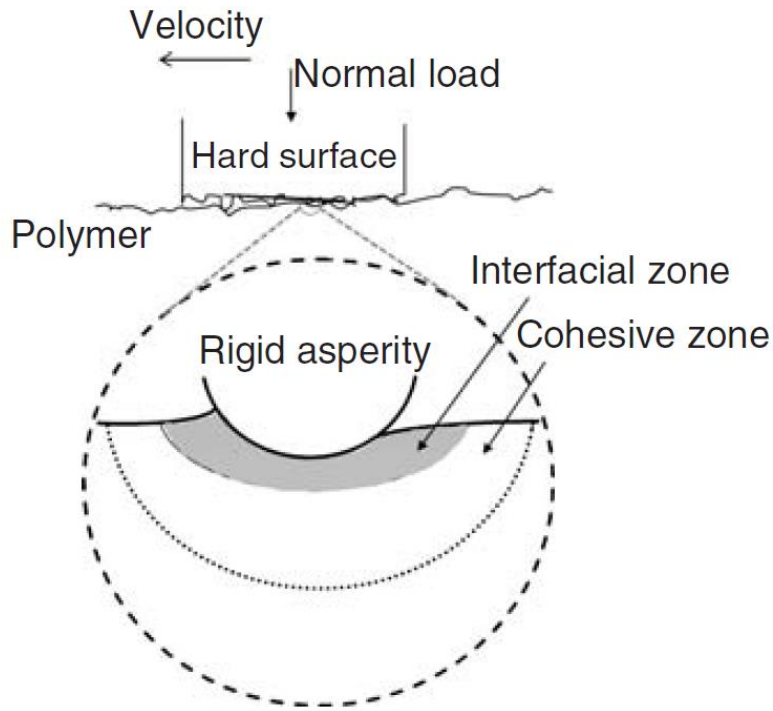
Scratch Resistance of ATSP

ATSP Innovations

www.atspinnovations.com

Background

For polymer tribology



Two-term model of polymer interface, Briscoe 2002

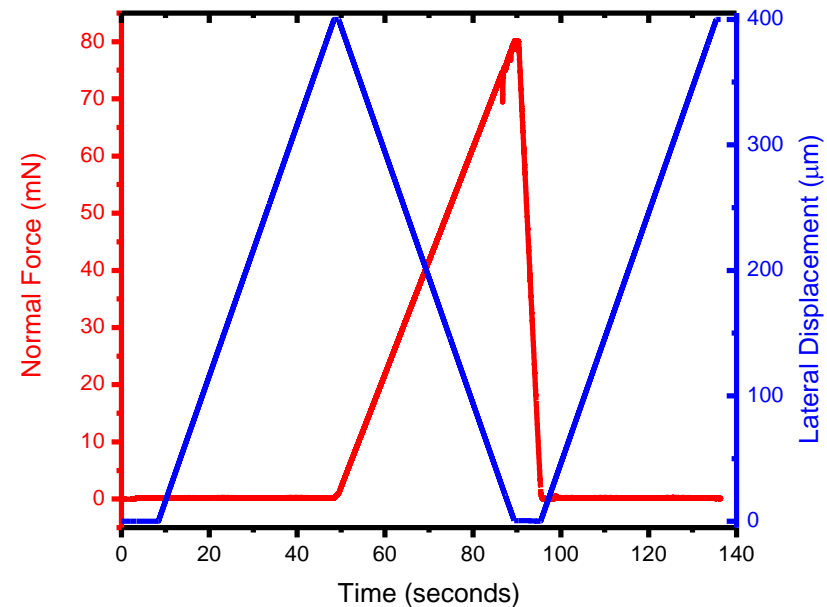
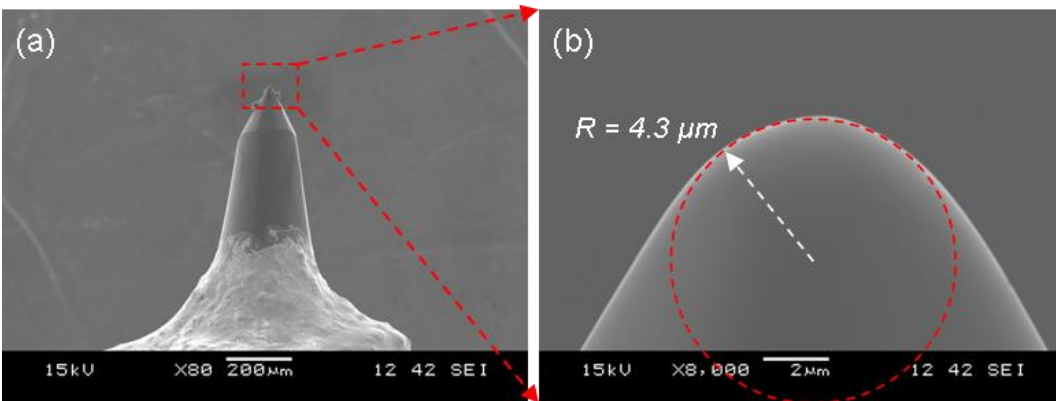
- Frictional behavior of polymeric surfaces is determined by the elastic/plastic property which is temperature dependent:

Higher T_g -> lower adhesion

- A higher ratio of deformation occurring as recoverable elastic deformation is preferable as this reduces wear and COF
- **This document shows ATSP's extraordinarily high elastic recovery and low deformation COF and ratio of deformation occurring as recoverable elastic deformation relative to other polymeric performance coating systems**
- **ATSP has an extremely high glass transition temperature and so maintains this property in demanding conditions**

Experimental details

- Hysitron Triboindenter with 3D Omniprobe
- Ramped Load Scratch-type experiment with retrace
- 4.3 μm diamond conospherical indenter tip
- Pre-scan to acquire surface topography (400 μm line)
- 80 mN Ramped Load
 - 2 mN/s load rate
 - 10 $\mu\text{m}/\text{s}$ transversal
- Post-scan to observe elastic/plastic character of deformation



Lower COF during scratch translates to lower real contact area.

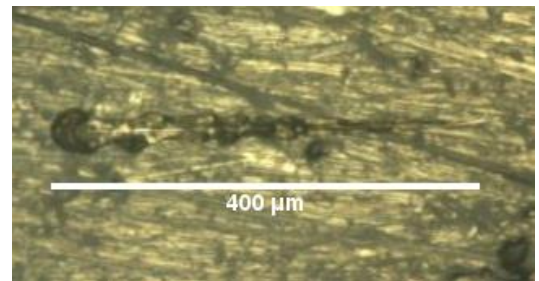
More of the scratch depth for ATSP exists as recoverable elastic deformation.

Tribologically relevant to resistance against scarring by debris/asperities.

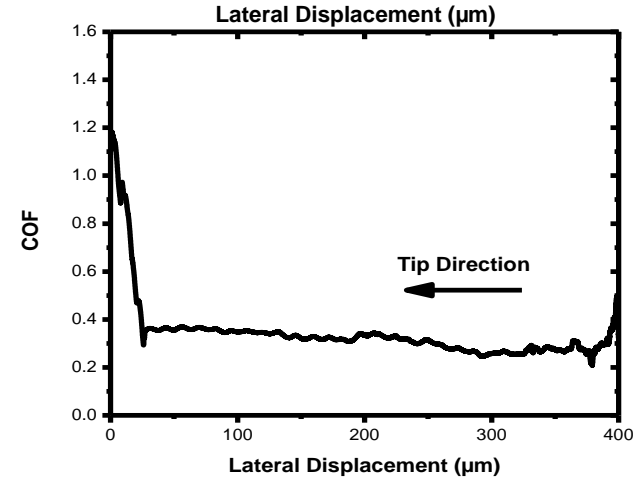
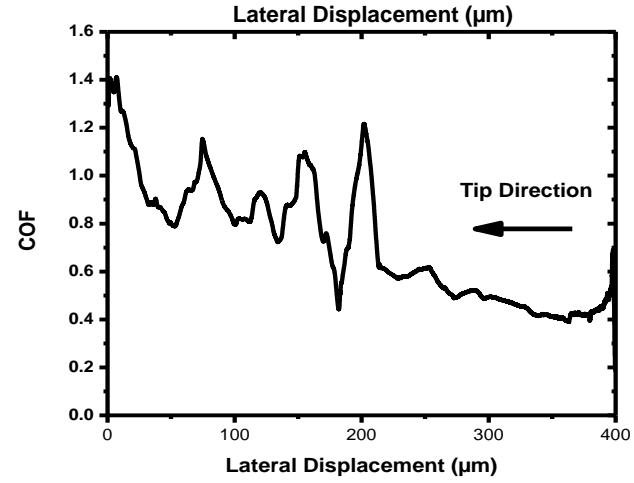
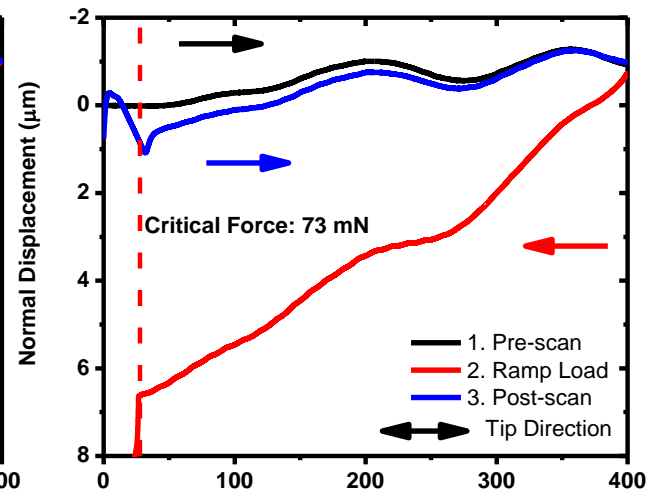
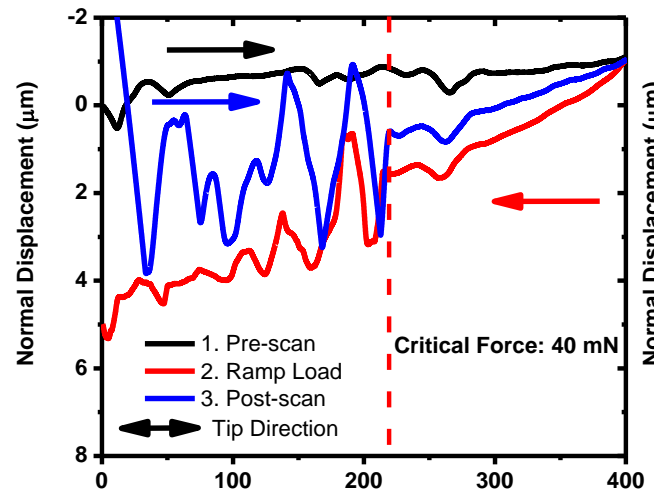
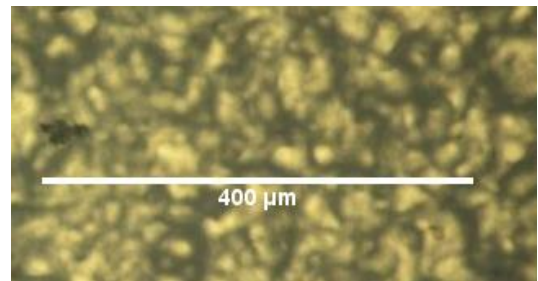
Tip Normal Displacement

COF During Ramp Load

Neat P84

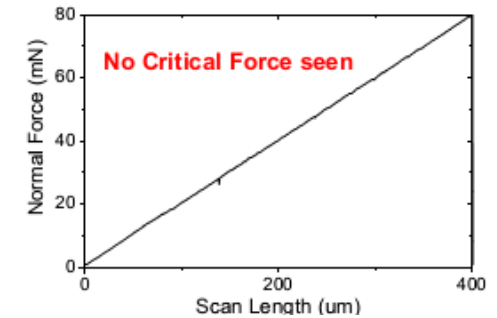
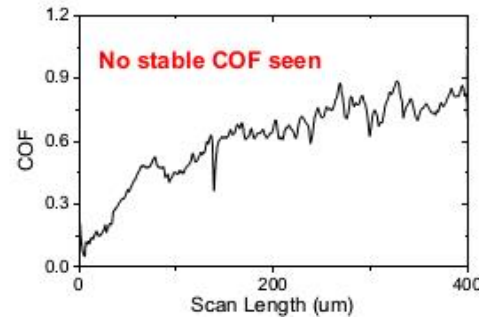
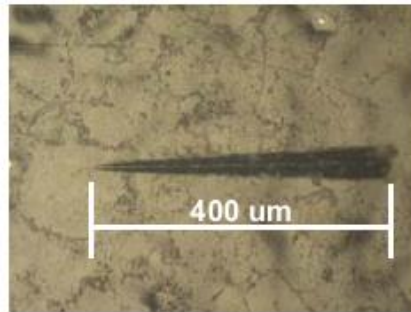


Neat ATSP S-7

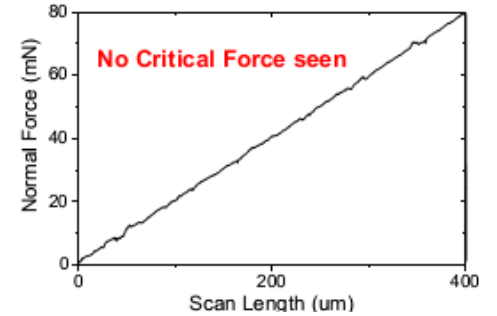
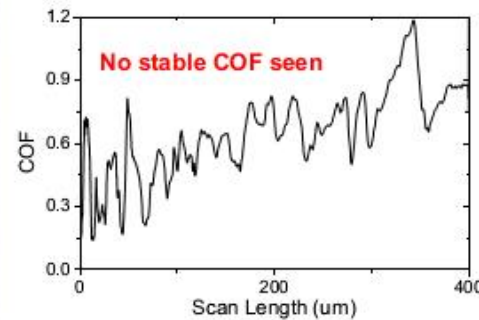
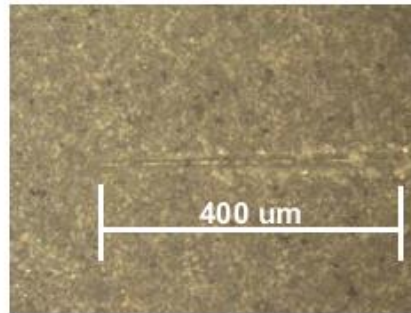


Ramp Load - Scratch Test (80 mN)

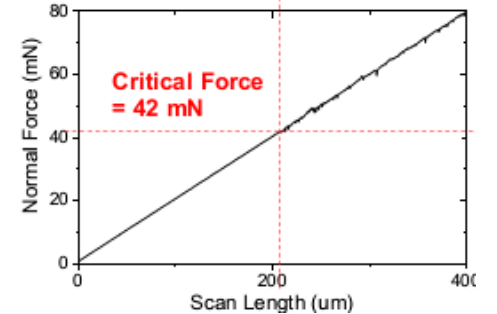
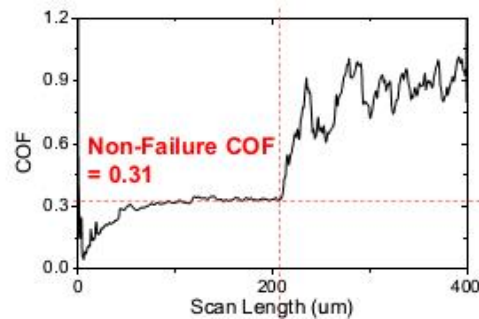
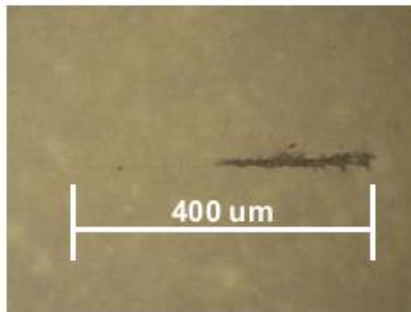
DuPont 958-414
PAI/PTFE



PEEK/PTFE

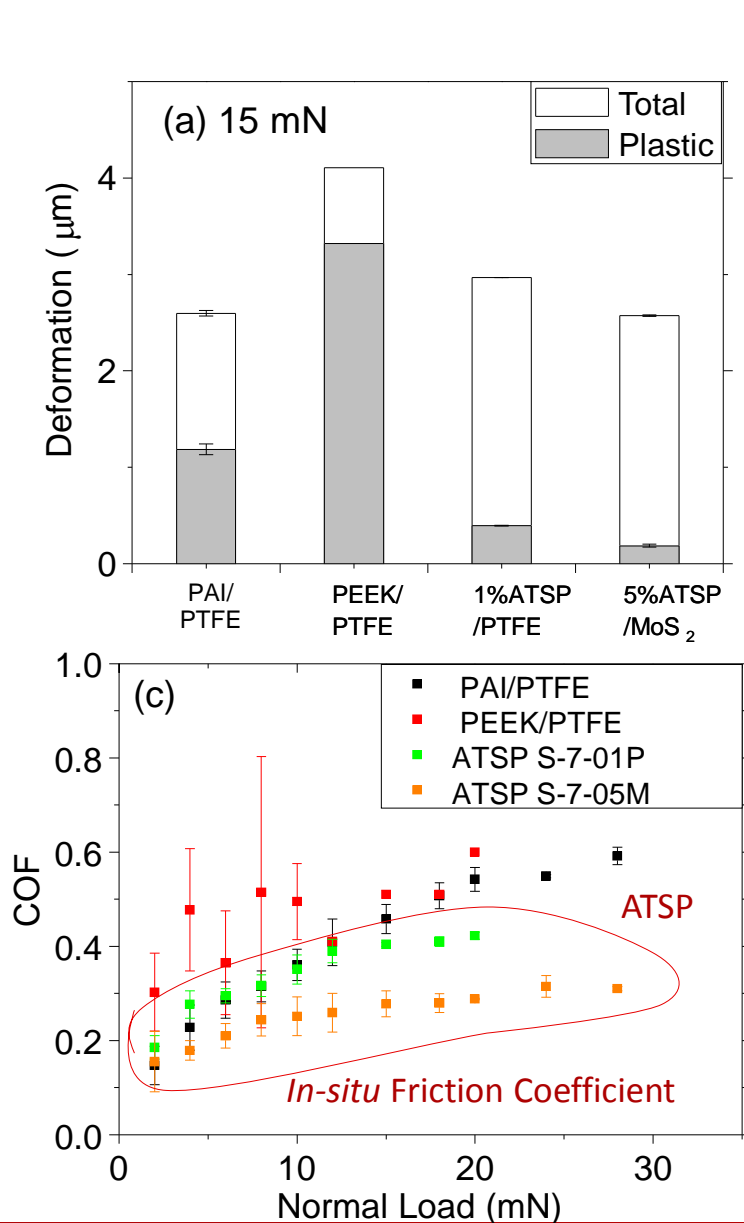


ATSP
S-7-05P



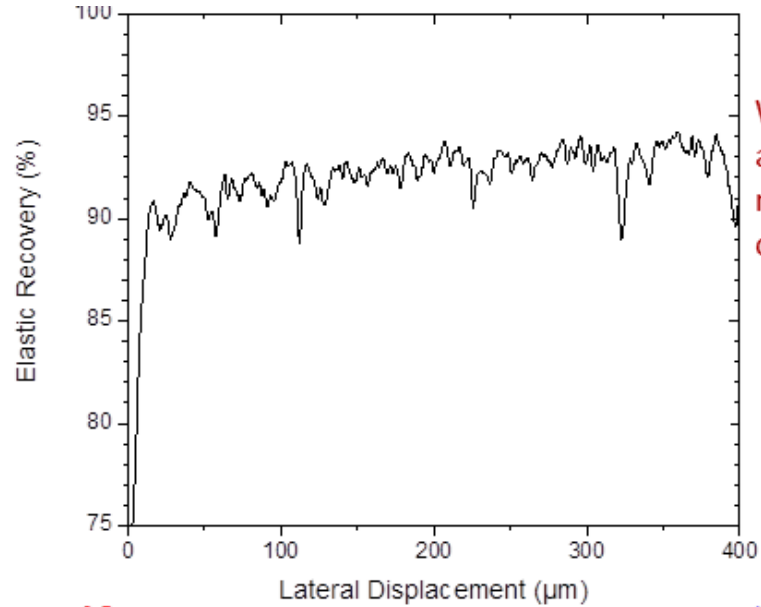
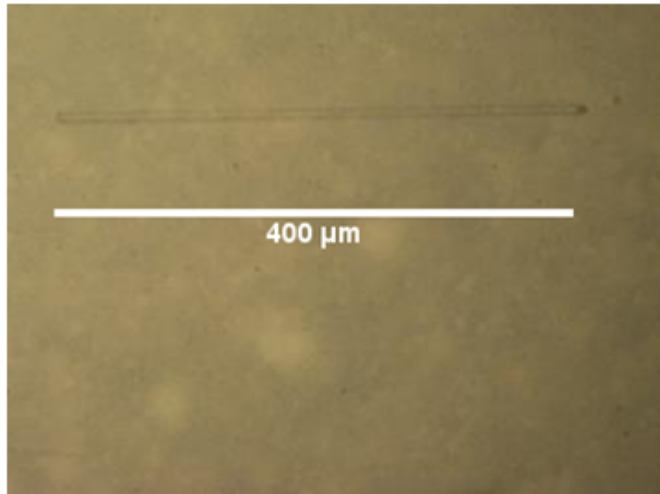
- ATSP coatings demonstrated an almost complete elastic recovery when compared to other commercially available polymeric coatings while still retaining a low and stable COF.

Elastic Recovery Property - Scratch Tests

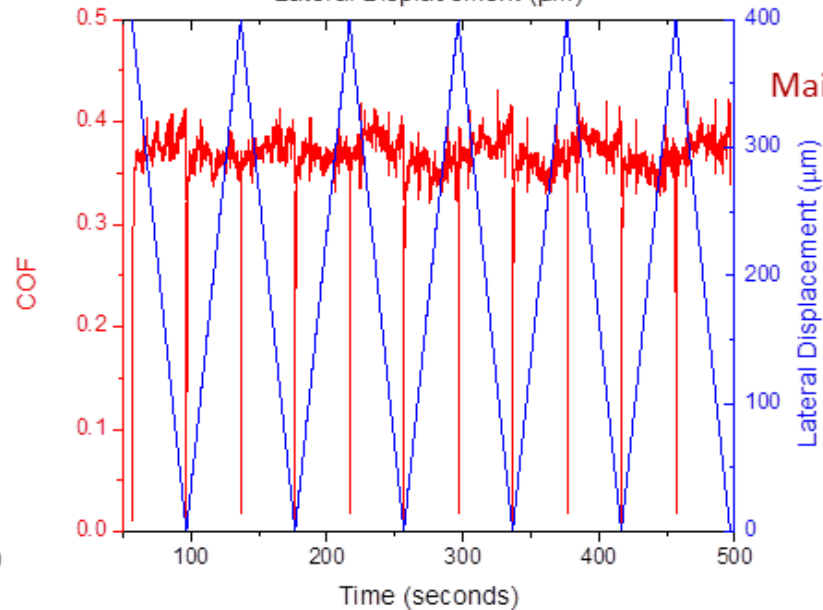
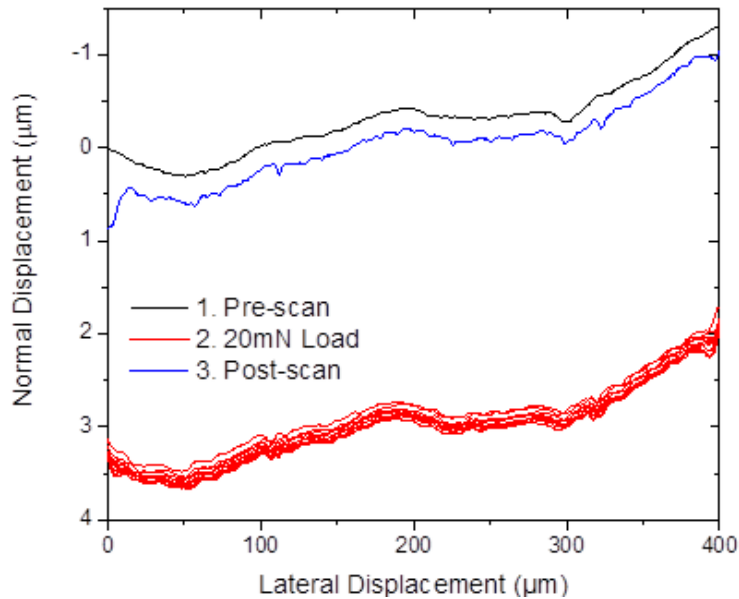


- ATSP exhibits significantly less plastic deformation
- Polymers with higher elastic recovery showed better frictional behavior → Due to smaller real contact area

Cyclic Scratching of ATSP S-7-05P; 20 mN;



With multiple cycles at high contact stress, maintains a steady-state, debris-less wear profile.



Maintains constant COF

Results Summary

Coating Type	Testing Conditions	Critical Force (mN)	Non-failure COF	Elastic Recovery (%)
ATSP S-7*	80mN / 400um	69-80+	0.3-0.33	92-98
ATSP S-7-05P*	80mN / 400um	42-48	0.34	90-95
ABS	80mN / 400um	N/A	N/A	---
PC	80mN / 400um	56	0.96	---
PTFE	80mN / 400um	N/A	N/A	---
PAI/PTFE	80mN / 400um	N/A	N/A	50-65
DGEBPA Epoxy	80mN / 400um	N/A	N/A	40-60
Kapton	80mN / 400um	50	0.50	60-86
P84	80mN / 400um	38	N/A	40-60
PEEK/PTFE	80mN / 400um	N/A	N/A	15-20

Key message: Coatings with a higher critical force and elastic recovery are more scratch and abrasion resistant.

ATSP has an exceptional ability to recover deformation even at high stresses from sharp indenters while producing no wear debris.