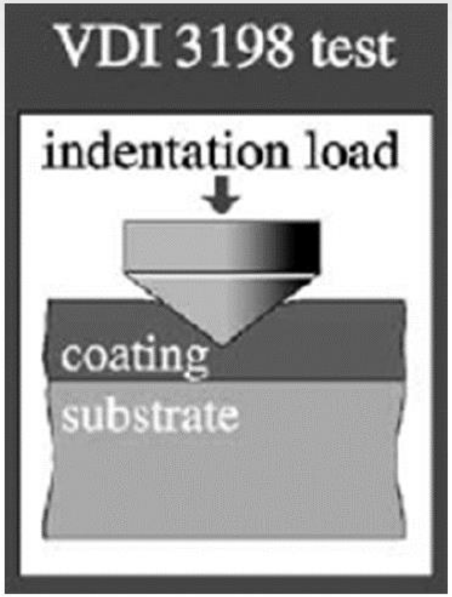
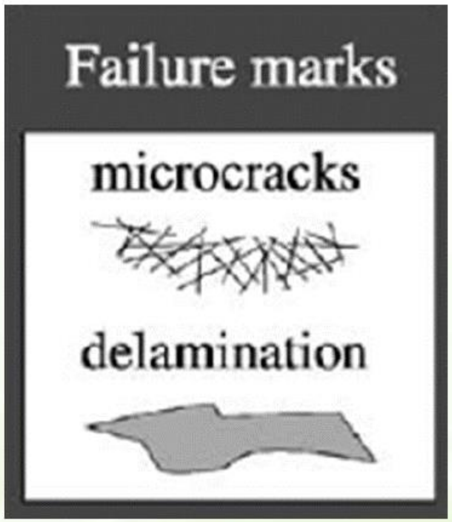
Adhesion

Rockwell C Hardness Test (VDI3198)





N. Vidakis et al. / Journal of Materials Processing Technology 143–144 (2003)

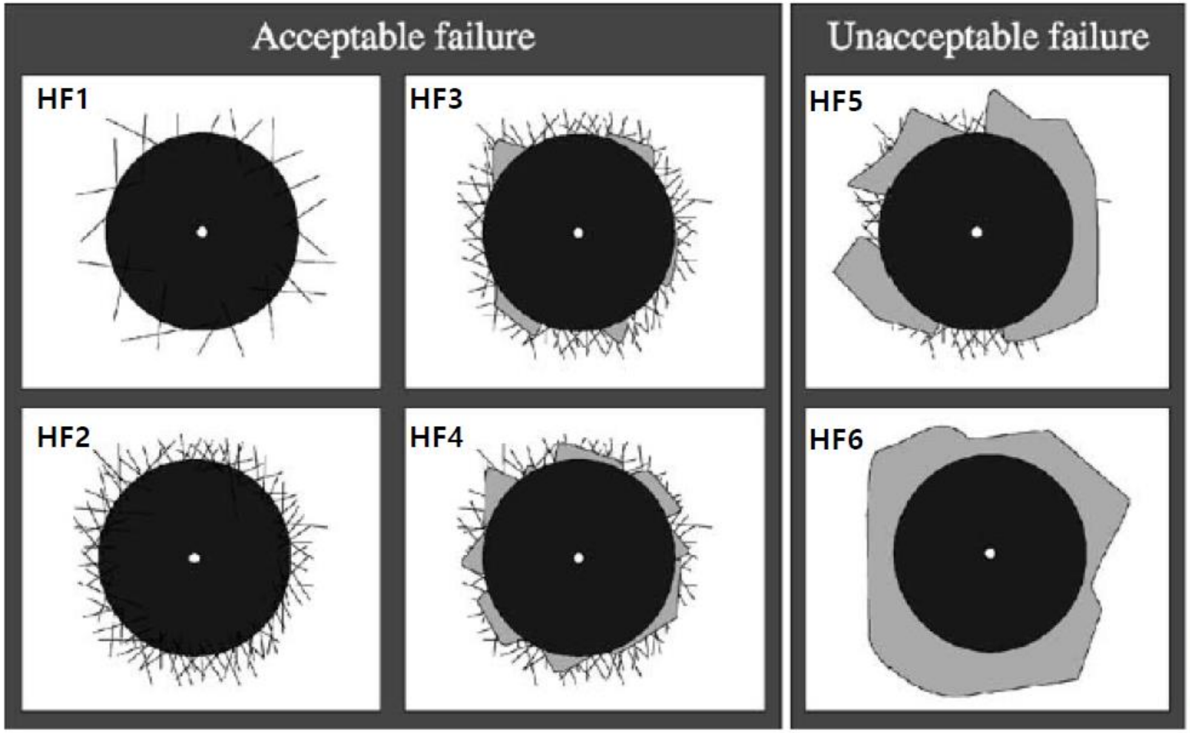


Fig. 1. The principle of the VDI 3198 indentation test.

DLC compare with Tungsten carbide (Rockwell test)

<Crystal structure>

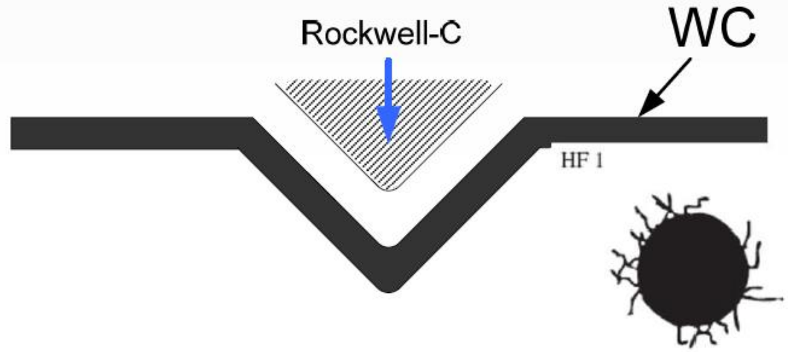
Tungsten carbide(WC) : bcc structure

- ***slip, twin crystal, lamination layer, dislocation***

  >>> plastic deformation

- ***Young's Modulus high***

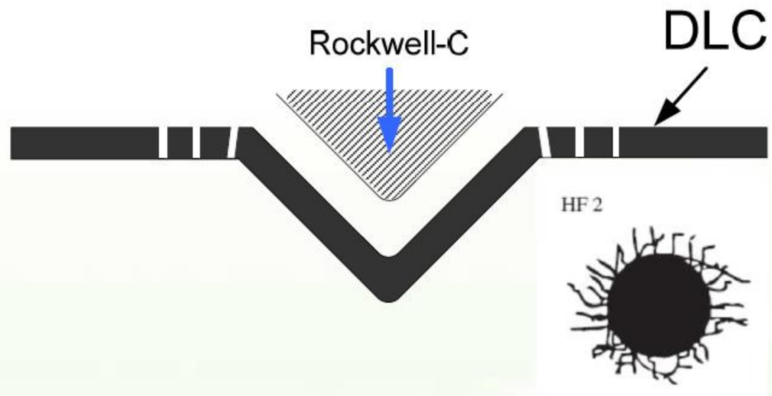
  ➔ ***Rockwell test result → good***



DLC : Amorphous

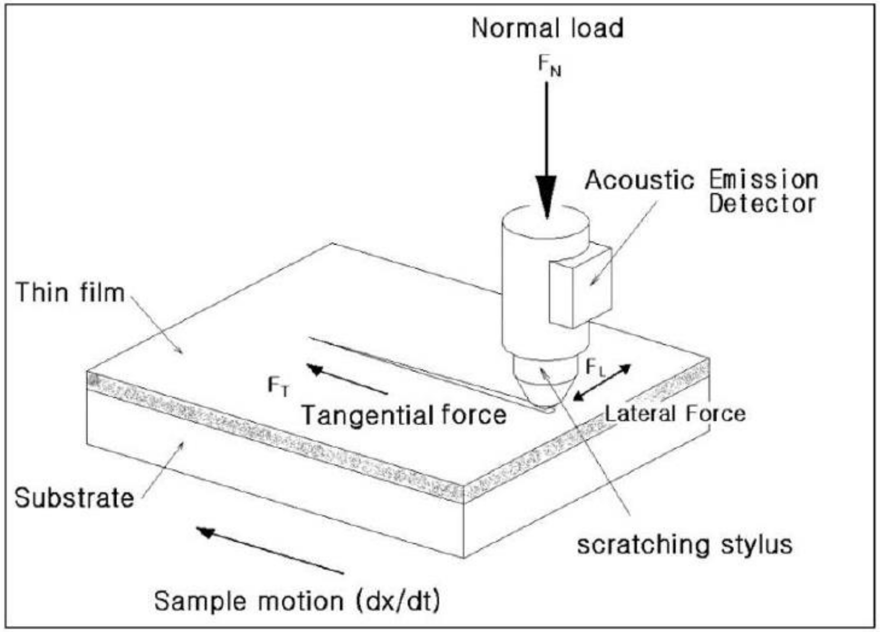
- ***Young's Modulus low***

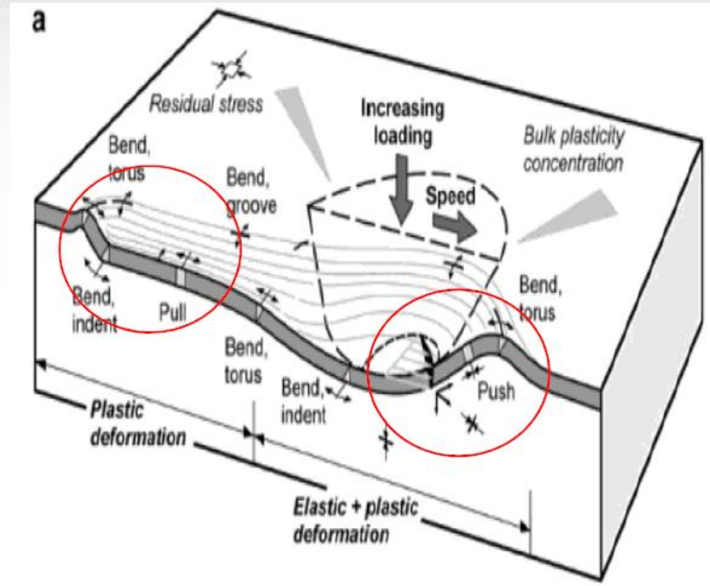
  ➔ ***Rockwell test result → inferior to WC***

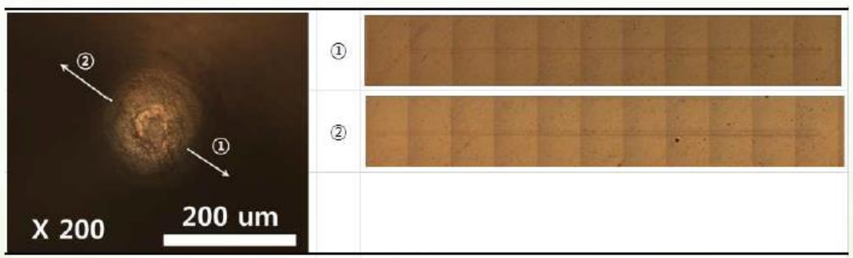


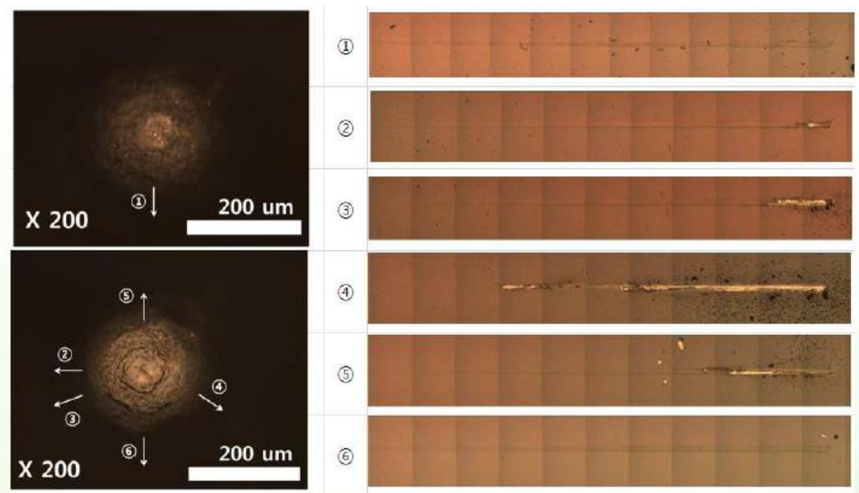
- **Design of Buffer layer**
- **Control of DLC stress**

Principle of Scratch test









Scratch test failure modes

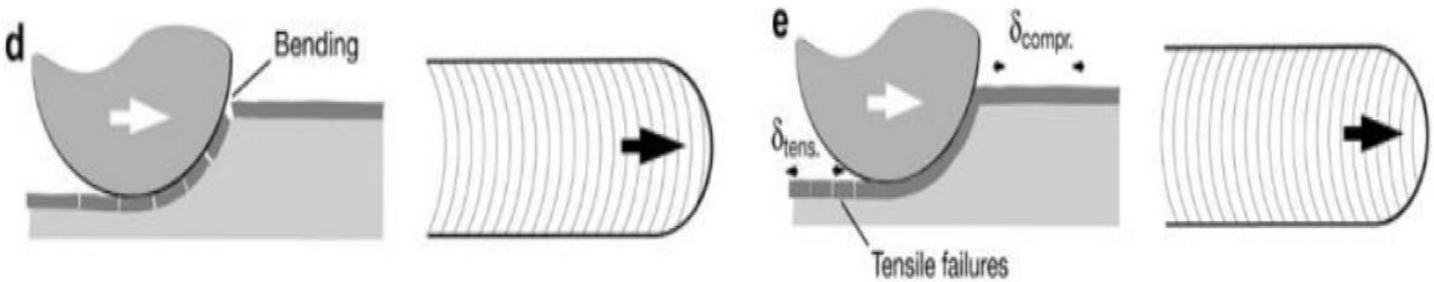
KIMS

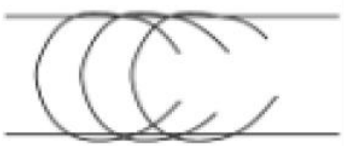
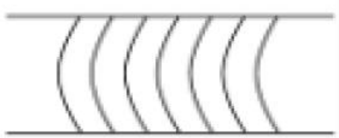
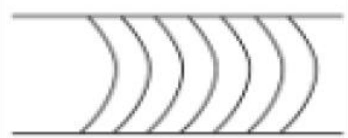
Major Scratch Test Failure Regimes

- 1) Through-thickness cracking

  : Including **tensile cracking** behind the indenter

  * Tensile stress depend on tip and coating friction traction



1. Coating – cracking related			
Hertz tensile cracks	Tensile trailing cracks	Forward chevron tensile cracks	Conformal cracks
→ Scratch direction	→ Scratch direction	→ Scratch direction	→ Scratch direction
			

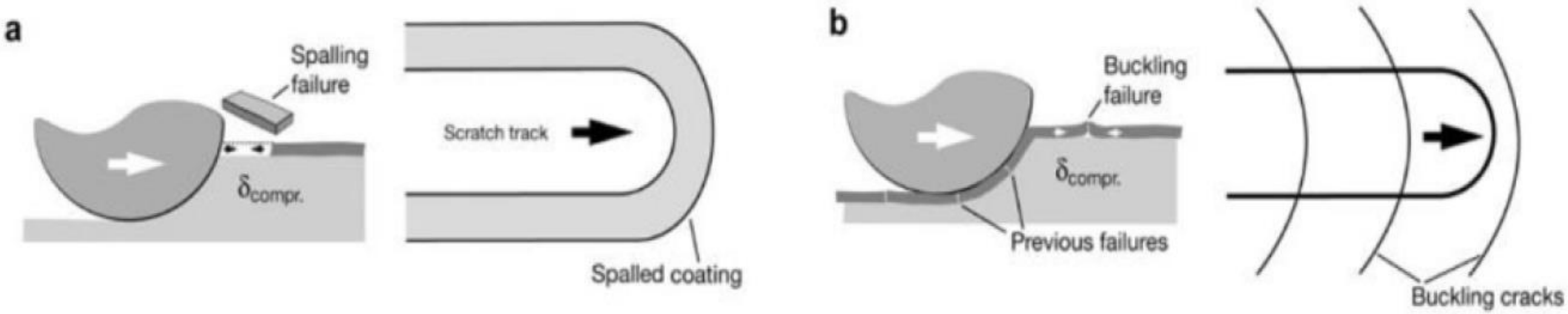
test load, coating thickness, residual stress(coating), substrate hardness, interfacial adhesion

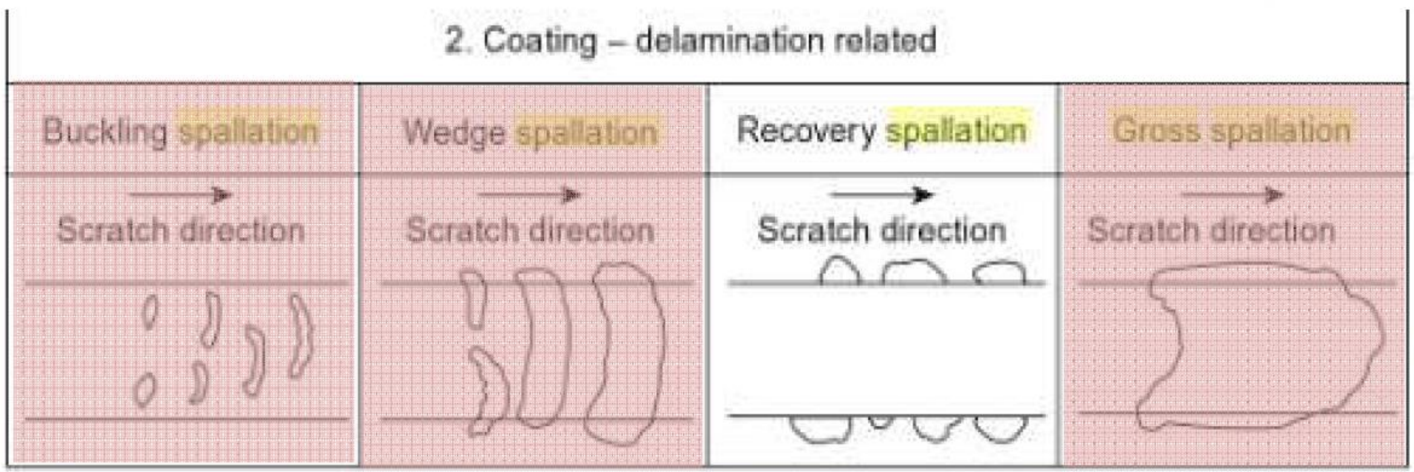
KIMS

Major Scratch Test Failure Regimes

2) Interfacial failure cracking

: Including **compressive stress ahead** the indenter

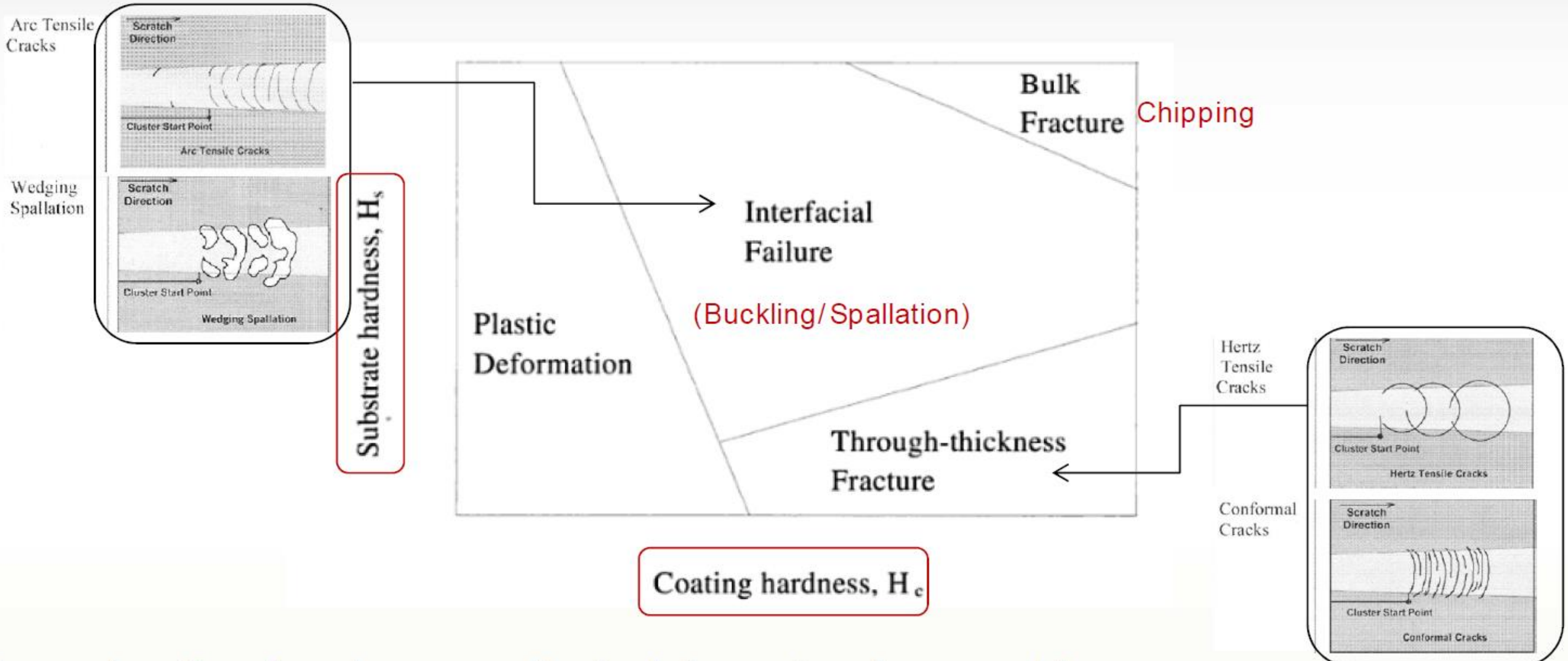




Failure modes

KIMS

Major Scratch Test Failure Regimes



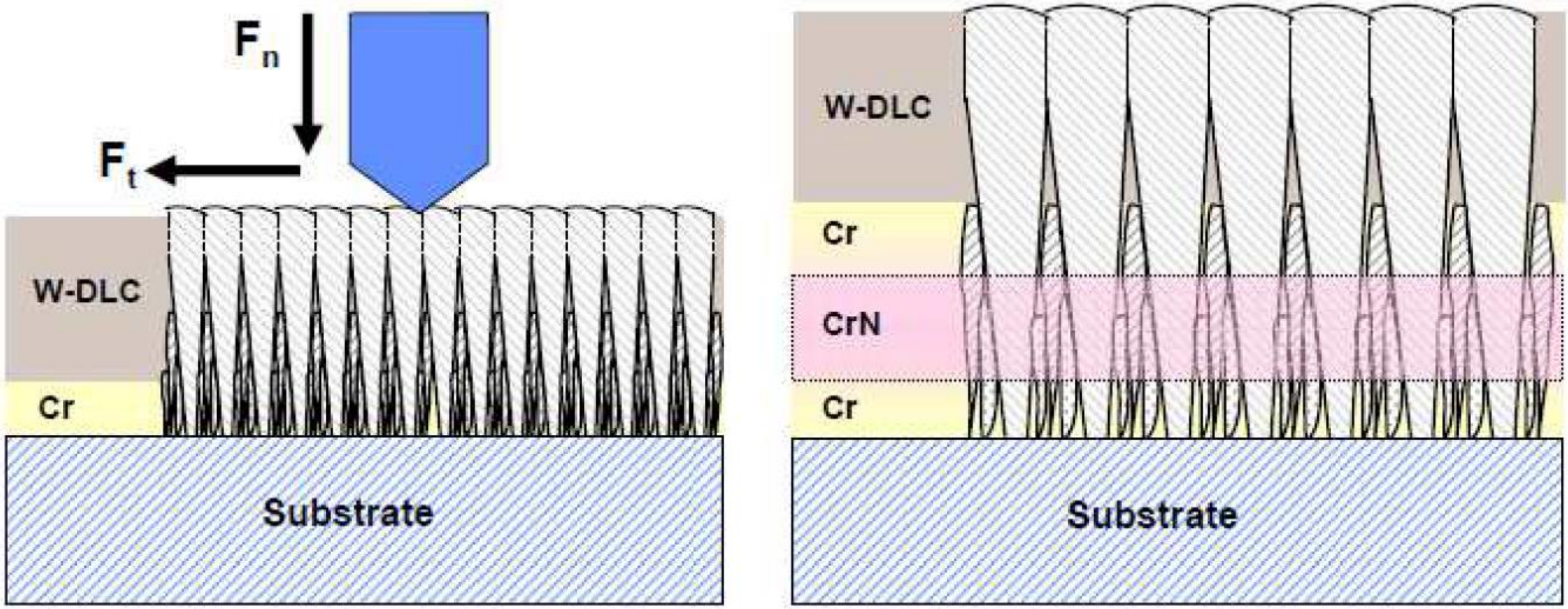
- **Soft coating & soft substrate** : plastic deformation & no cracking
- **Hard coating & soft substrate** : fracture and cracks
  (created by plastic deformation of the substrate)
- **Soft coating & hard substrate** : deform by plastic deformation & extrusion of the coating
  from between the stylus and the substrate
- **Hard coating & Hard substrate** : Minimal plastic deformation fracture dominates

Improved adhesion of DLC coatings

KIMS

Defined interlayer systems

Models of the growth structures



W-DLC (L_{C2} = 35 N)

CrN + W-DLC coating system (L_{C2} = 78 N)

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Improved adhesion of DLC coatings

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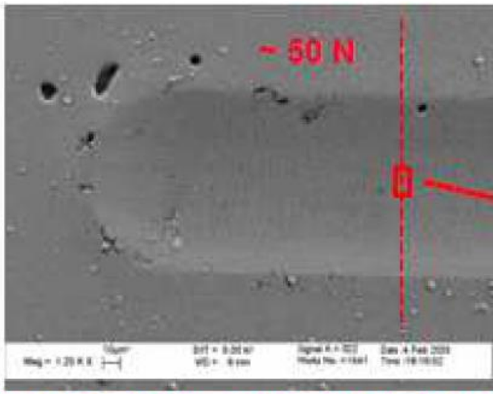
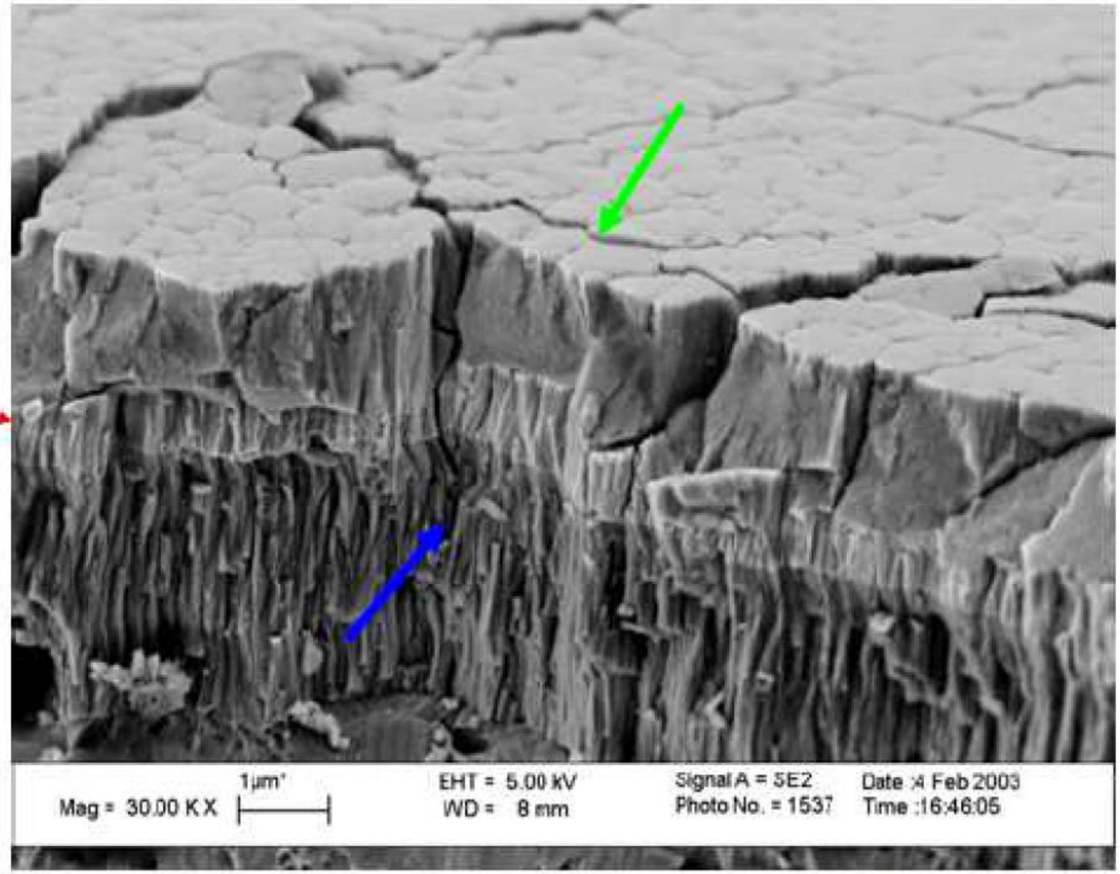
Interlayer systems

Fracture pattern across wear track after scratch testing (single-pass)



- Crack propagation along growth structure.
- Crack stop in the ductile CrN interlayer



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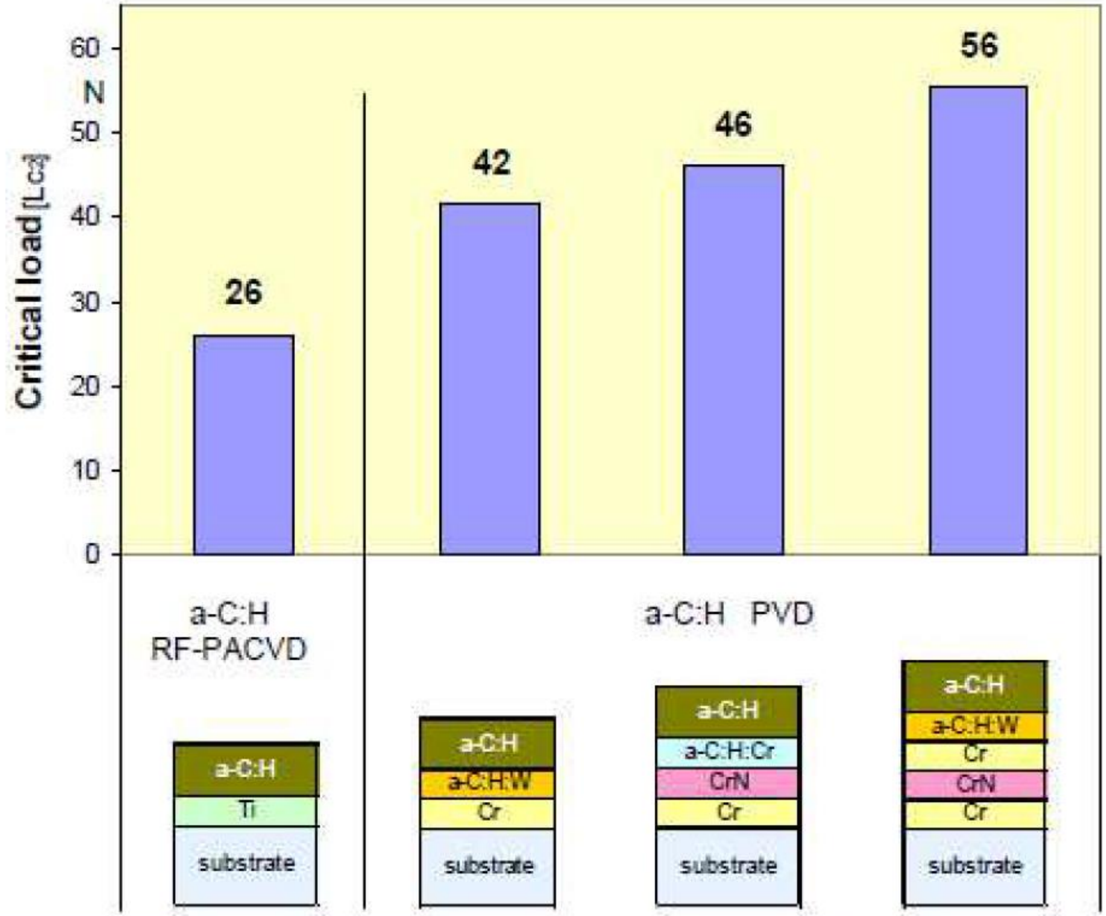
Influence of difference interlayer

Defined interlayer systems

Critical load on flat samples

- Best adhesion of a-C:H on a-C:H:W
- Good adhesion of a-C:H on a-C:H:Cr only on flat samples
- CrN can stop cracks and has a supporting function
- No influence of bias voltage on adhesion and critical load



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