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Novel carbonaceous film with high electrical conductivity and super high hardness for semiconductor test probes.

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®

A newspaper article of the novel carbonaceous film (Dec. 7th , 2010)

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導電性と硬さを両立
野村鍍金が表面処理材開発

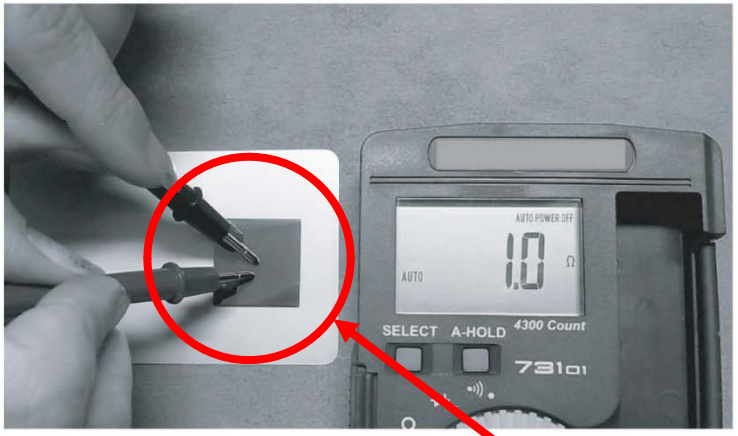
野村鍍金（大阪市西淀川区、野村修平社長、06・6471・0966）は、導電性と硬さを併せ持つ表面処理材を開発した。硬度は一般的なダイヤモンドライクカーボン（DLC）の約2倍で、抵抗値が同程度の導電性DLCの約4倍の硬度を持つ。半導体や電子部品などの検査用針（プローブ）を中心に、同表面処理の採用を提案する。

自社の硬質コーティング材「タフカーボン」に、導電性を高める独自物質を添加して完成した。プローブに処理した場合の抵抗値は約1ミリオームで高い導電性を確保する。皮膜硬度はビッカース硬度（HV）4000で、DLCの2倍とした。

成膜温度が100度Cと低めのため、幅広い基材に処理できるのも特徴だ。表面が平滑に仕上がり、滑り性がよく汚れにも強い。硬くて密着性も高いため傷や剥離などが発生しにくい。さ50度Cまで硬さしない耐熱性もあ酷な使用環境に耐る。

処理費用は検が、プローブの場千本から請け負い当たりのコストをとする予定だ。

野村鍍金は工業キや溶射、特殊コングなどの表面処うほか、その技術してロールやモどの製造も手がけ2ロケットの主翼表面処理を担当ど、先端技術の評価も獲得してい



高硬度と導電性を両立した導電性タフカーボン（抵抗値： 1Ω）

Novel carbonaceous film

Japanese article is describing specifications and functions

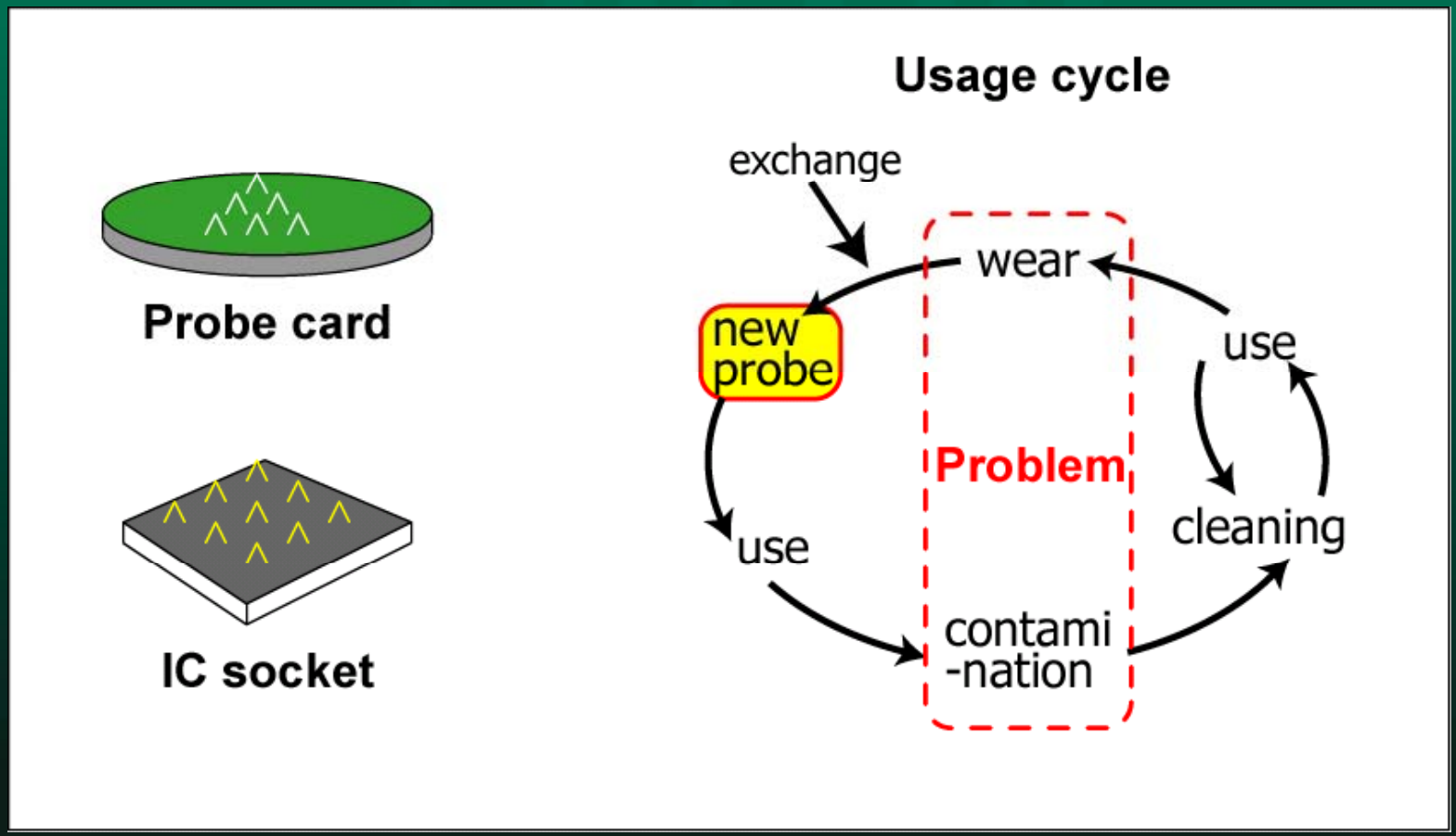
Outline

1. **What does the industry need in a probe surface?**
   - Introduction / Objective
2. **Can this carbonaceous film meet industry needs?**
   - Industrial issue
3. **How is this film produced?**
   - Production method
4. **Why were these film features developed?**
   - Discussion
5. **Are there any weaknesses of this film?**
   - Care points of practical use
6. **Summary**

Introduction / Objective

1. WHAT DOES THE INDUSTRY NEED IN A PROBE SURFACE?

Industry needs a probe surface with electrical stability, and wear-resistance



Problem -> Solution

- Wear -> High hardness (wear-resistance)
- Contamination (decrease of electrical stability) -> Surface stability

Present surfaces don't fully meet industry requirements

Surface Treatment	Hardness	Contamination	Electrical Conductivity
Au Plating	X (< Hv 250)	X	○
Palladium Alloy Plating	△ (Hv 350~400)	X	○
Rhodium Plating	△ (Hv 800~900)	X	○
Conductive DLC (Diamond-Like Carbon)	△ (Hv1000~2000)	△	△

[Key]
○ =very effective
△ =somewhat effective
X =ineffective

[Objective]

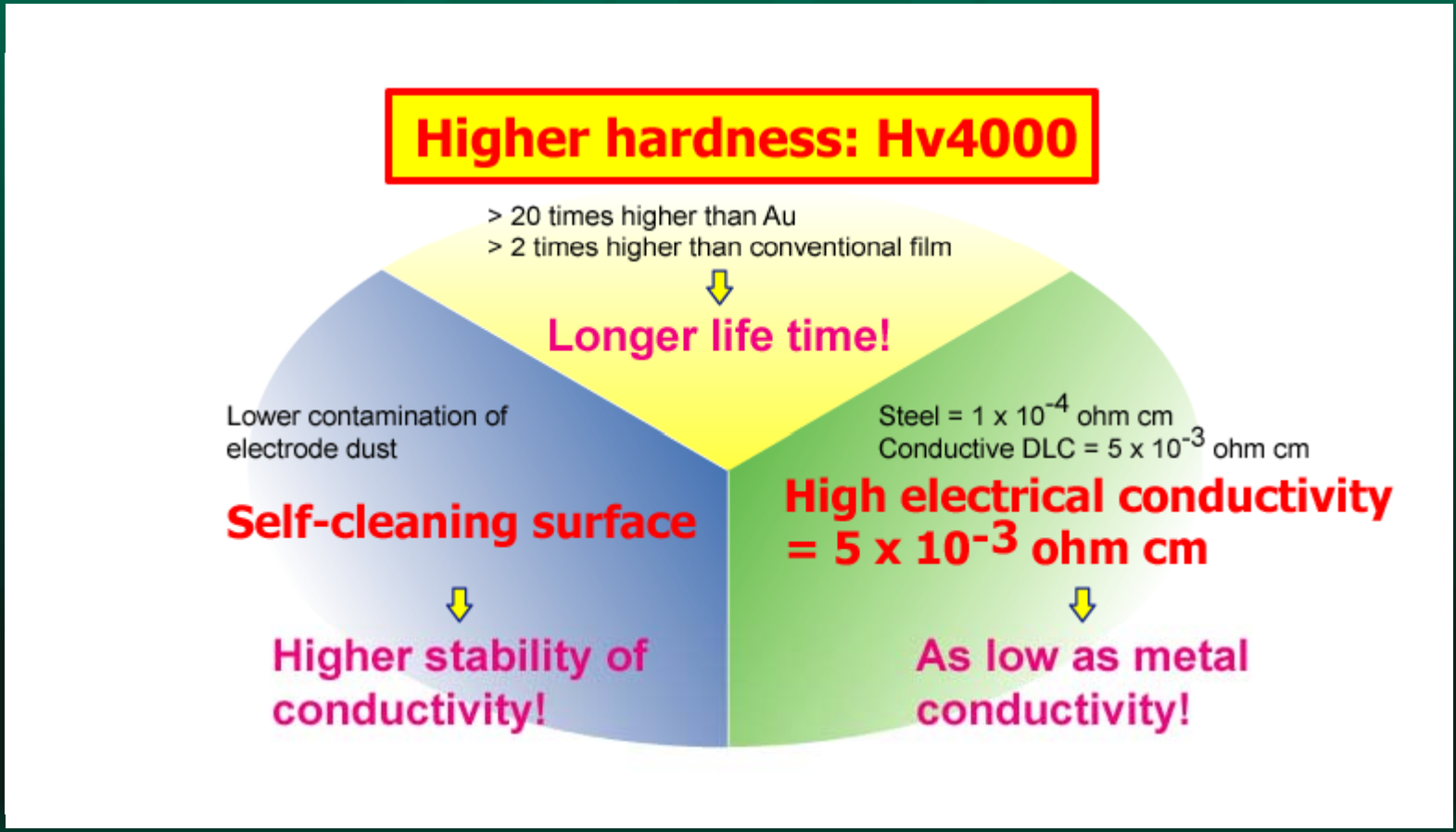
Developing surface treatment to sufficiently meet the requirements of probe users

Industrial issue

2. CAN THIS CARBONACEOUS FILM MEET INDUSTRY NEEDS?

YES, it can! , but why?

- **Because, this film has following properties.**

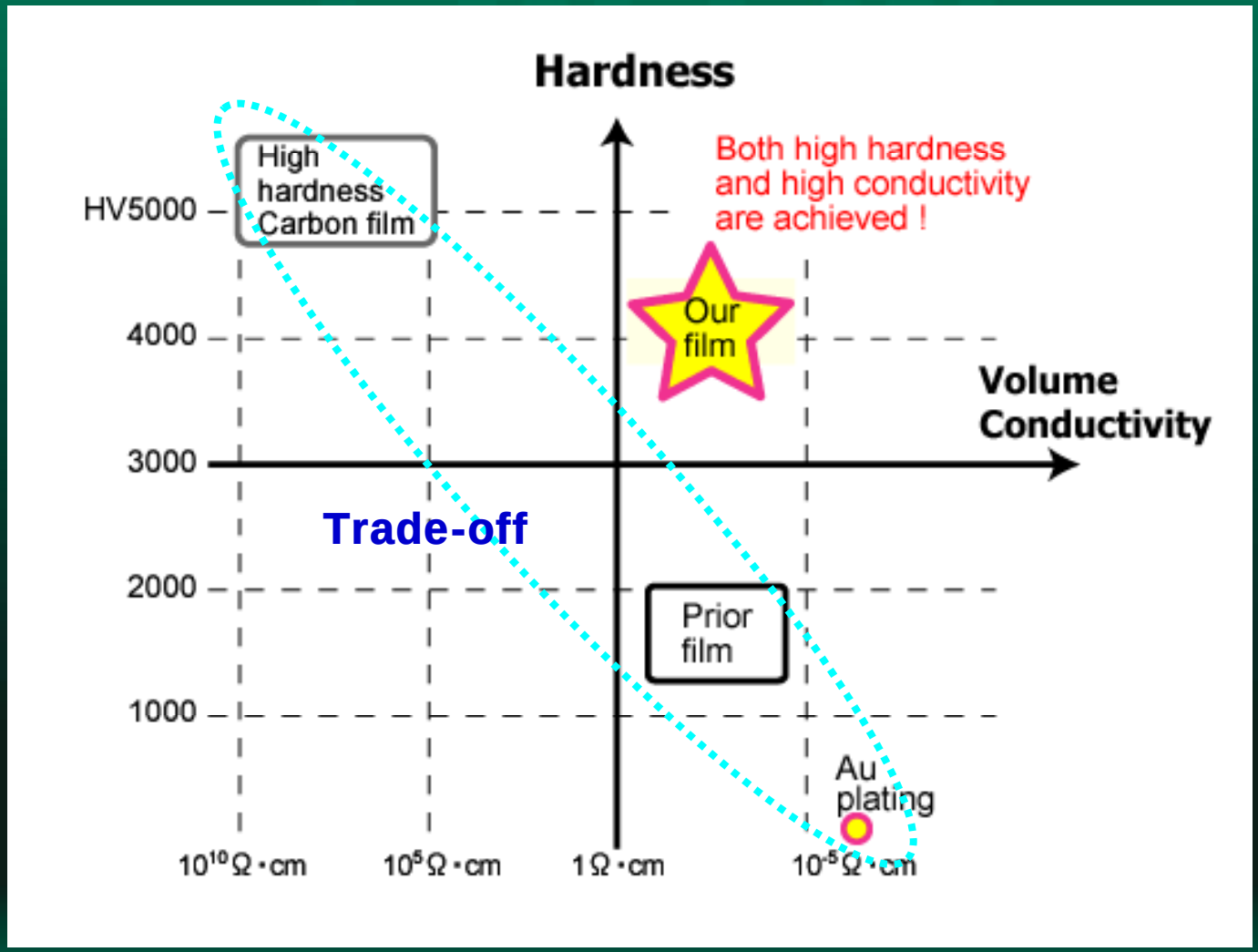


The film has the potential as future surface treatment for probes

Surface Treatment	Hardness	Contamination	Electrical Conductivity
Au Plating	X (< Hv 250)	X	○
Palladium Alloy Plating	△ (Hv 350~400)	X	○
Rhodium Plating	△ (Hv 800~900)	X	○
Conductive DLC (Diamond-Like Carbon)	△ (Hv1000~2000)	△	△
Our film	○ (Hv 4000)	○	△

[Key]
○ =very effective
△ =somewhat effective
X =ineffective

The film has an advantage compared with prior treatment



The film will give benefits to probe users

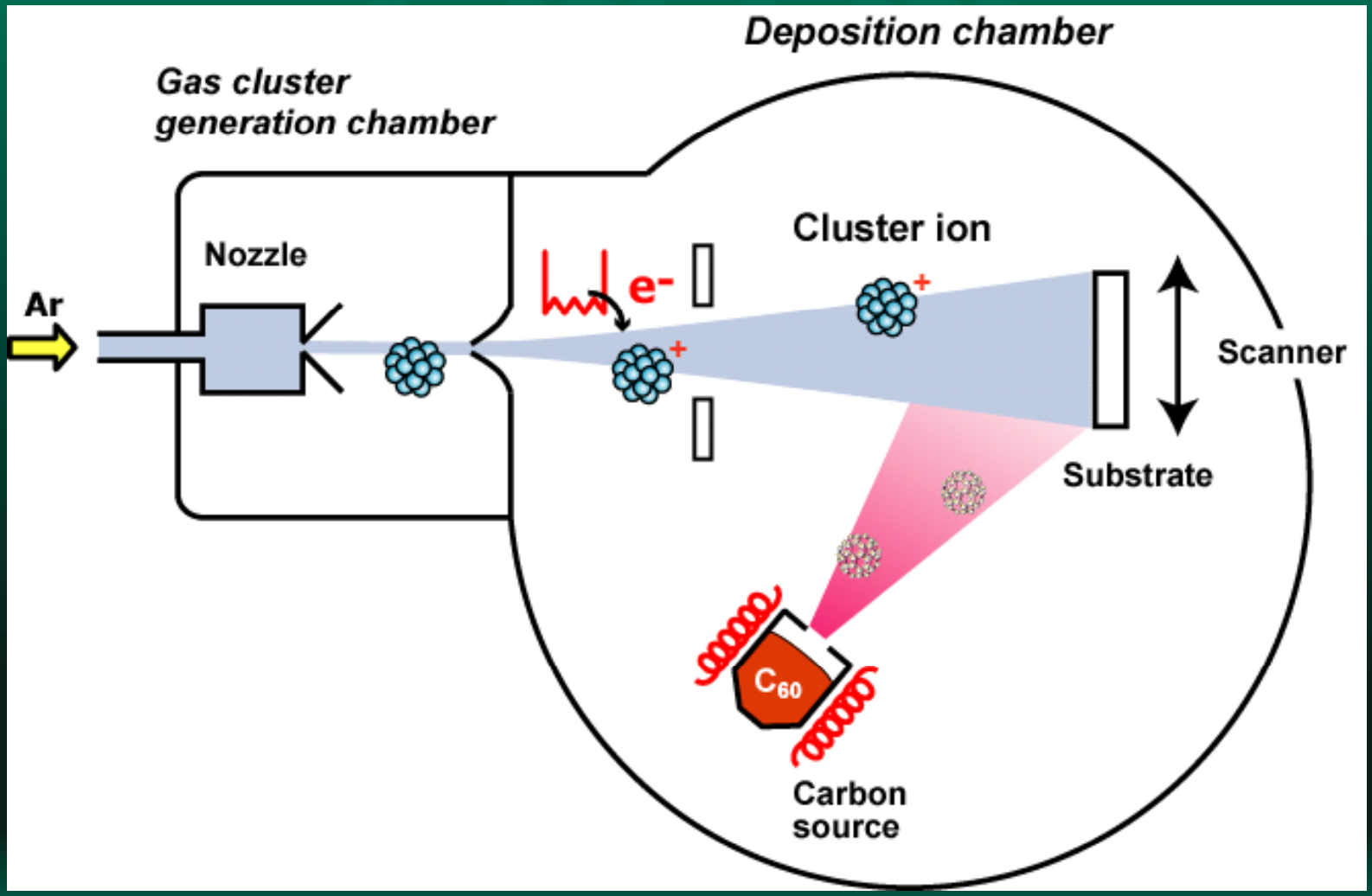
1. Lower costs for probe parts
   - Wear-resistance improvement, due to high hardness
2. Higher reliability for electrical measurement
   - Higher stability of electrical conductivity, due to self-cleaning surface
3. Higher throughput of the testing without additional cost
   - Decrease of maintenance frequency

     = Increase of testing time and decrease of labor costs for exchanging the probes

Production method

3. HOW IS THIS FILM PRODUCED?

Gas cluster ion beam process



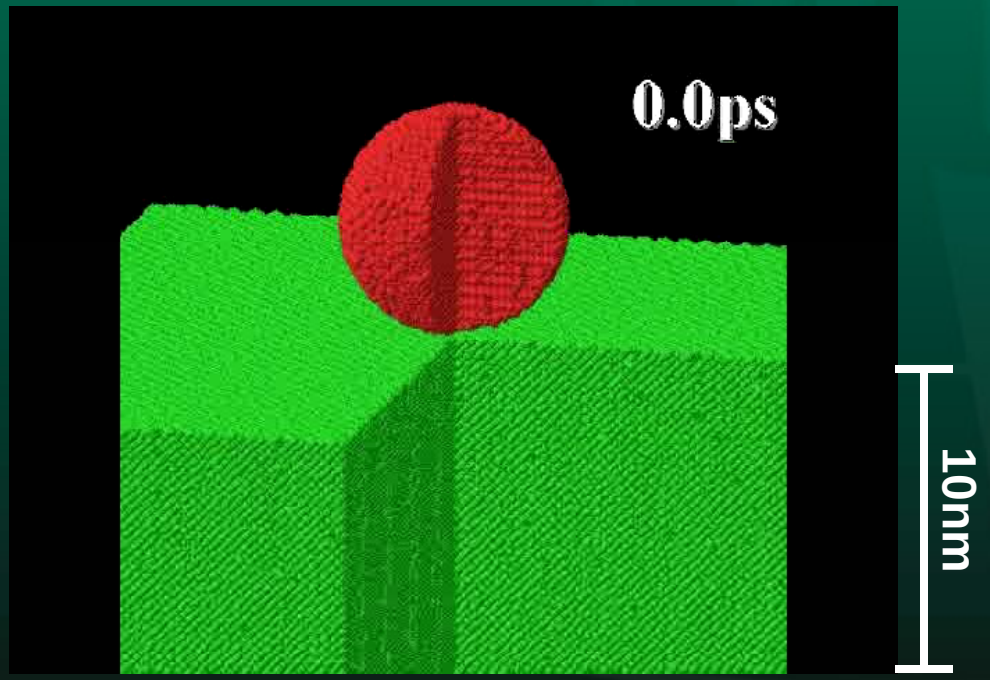
Discussion

4. WHY WERE THESE FILM FEATURES DEVELOPED?

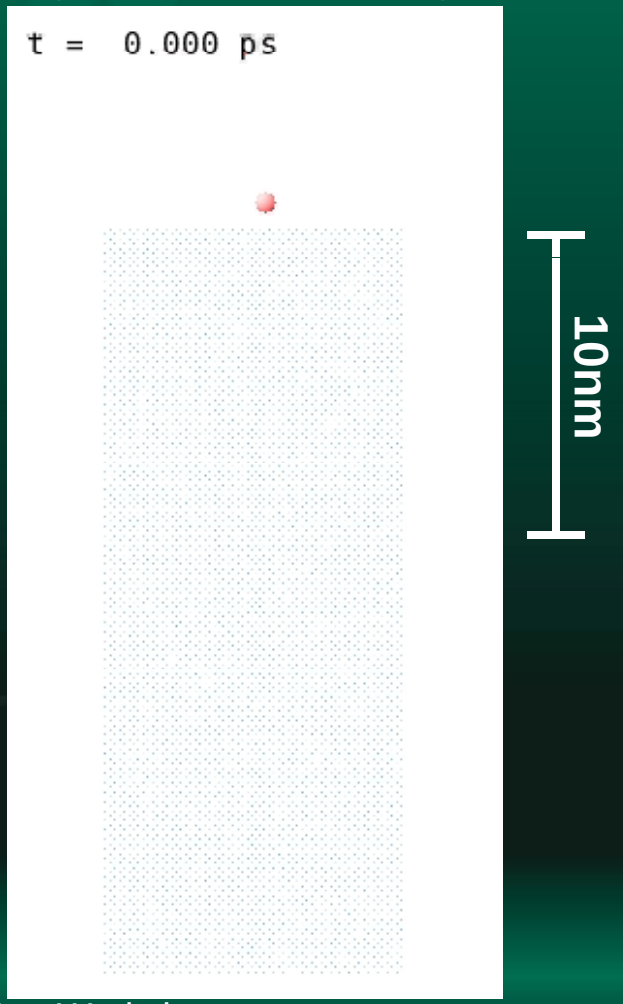
- (a) Irradiation effects of cluster ion
- (b) Higher hardness
- (c) High electrical conductivity
- (d) Self-cleaning surface

(a) Cluster ion impact is superior to conventional monomer ion

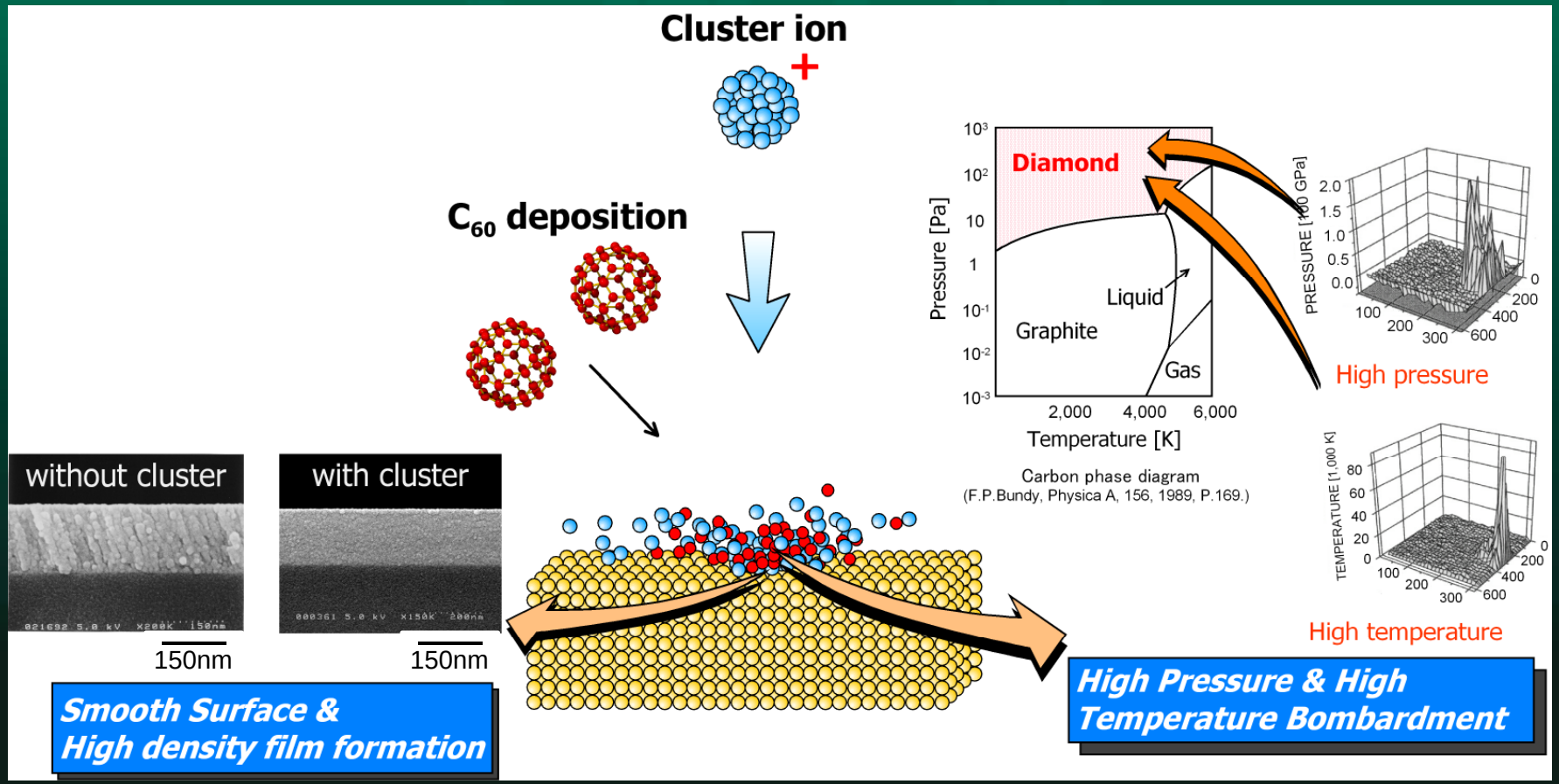
1. Cluster ion impact



2. Monomer ion impact (Conventional ion)



(a) High density bombardment effect of cluster ion is effective in depositing higher hardness film



(b) The higher hardness film using cluster process has been in practical use for longer life of parts

1. Precise mechanical parts

– ***LIFE: 2~4 times longer***

compared with DLC (Diamond-Like Carbon)

2. Cutting tool

– ***LIFE: > 10 times longer***

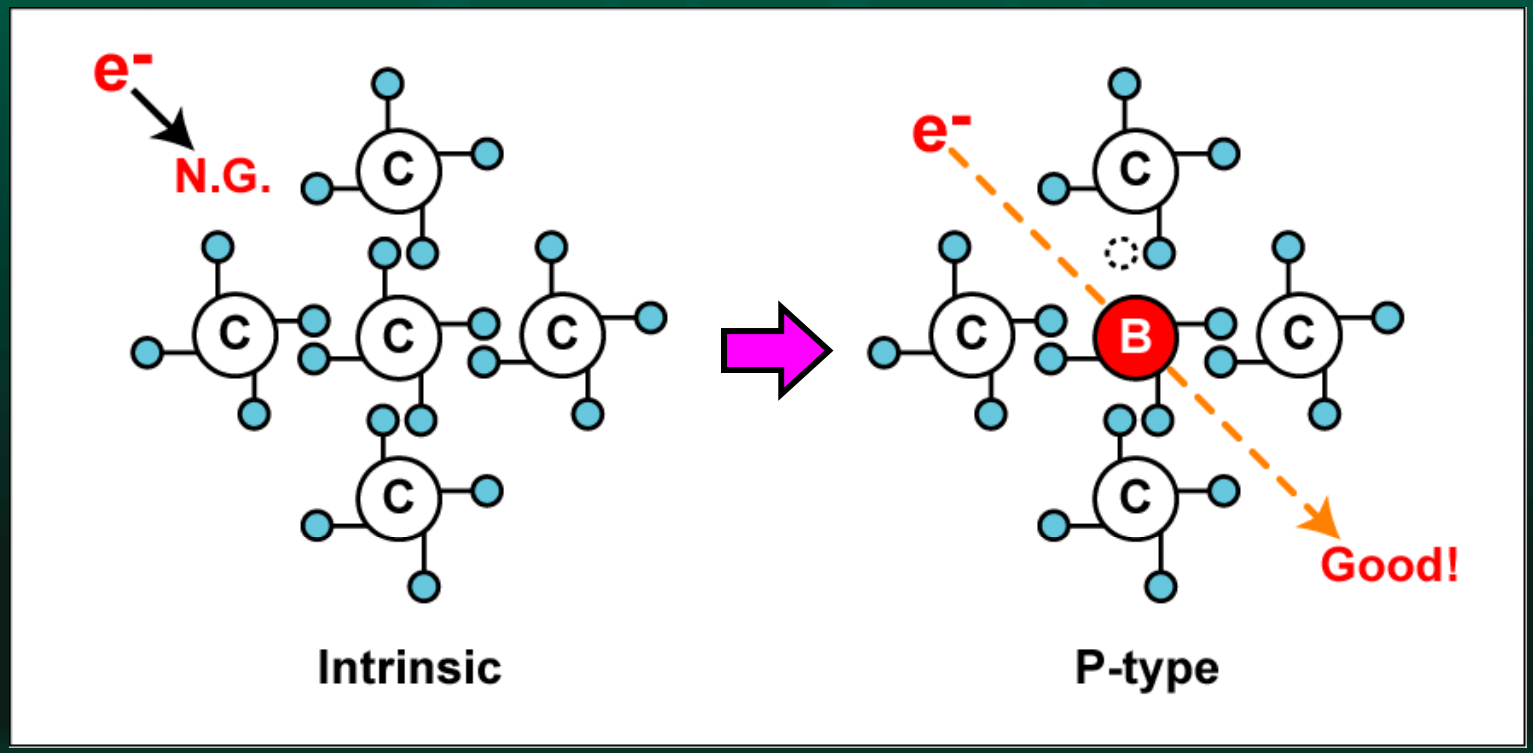
compared with non-coated tool (Material; WC)

<Film spec.>

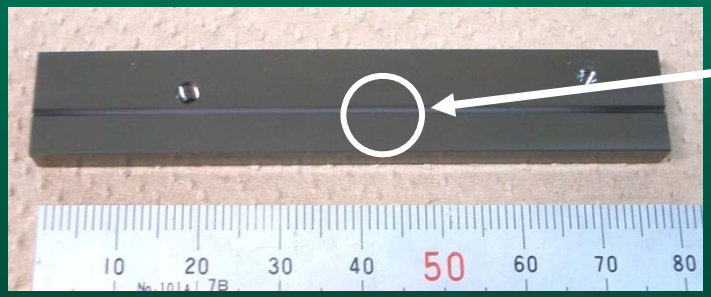
Hardness = Hv5000
Thickness < 0.3 um
Conductivity; Low

(c) High electrical conductivity is obtained with semiconductor technique

– Boron is doped in the film to obtain p-type conduction.



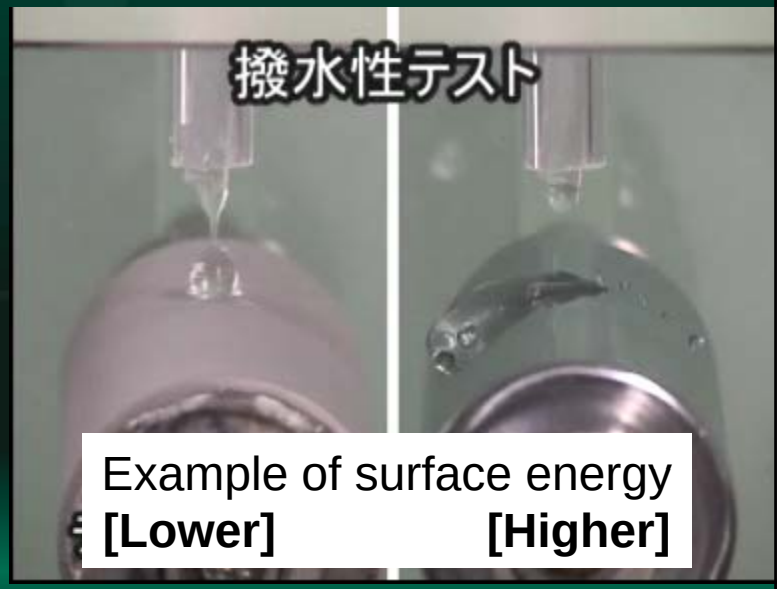
(d) Self-cleaning surface is given by lower surface free energy of the film



Lower contamination of tin

Picture: Parts feeder for MLCC
(Multi-Layer Ceramic Condenser)

- **Why does this film have a self-cleaning surface?**
  - Lower surface free energy
    - A characteristic of carbon
    - Higher bonding strength



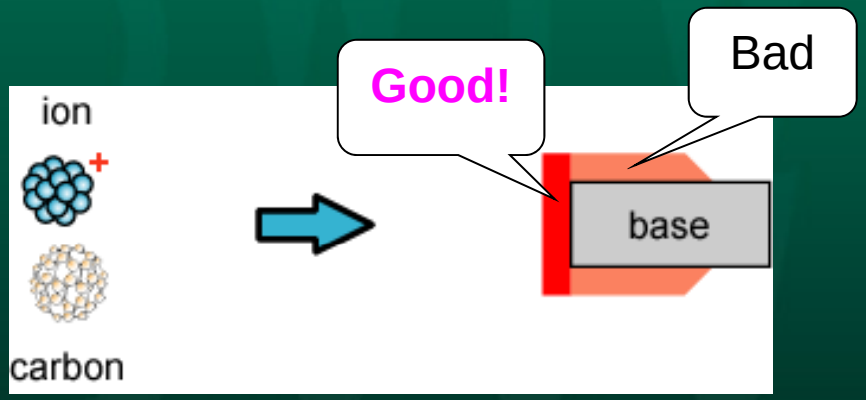
Example of surface energy
[Lower] **[Higher]**

Care points of practical use

5. ARE THERE ANY WEAKNESSES OF THIS FILM?

Yes, there are 2 weaknesses

1. **Film quality depends on irradiation angle of ion.**



2. **Practical evaluation of probes has not been fully performed yet.**

6. SUMMARY

1. The novel carbonaceous film has the properties of super hardness, high electrical conductivity, and self-cleaning surface.

2. The film has an unique surface treatment which can't be obtained with prior technique.

3. A practical use of the film will be expected, in order to give longer life and better measurement reliability to probes.

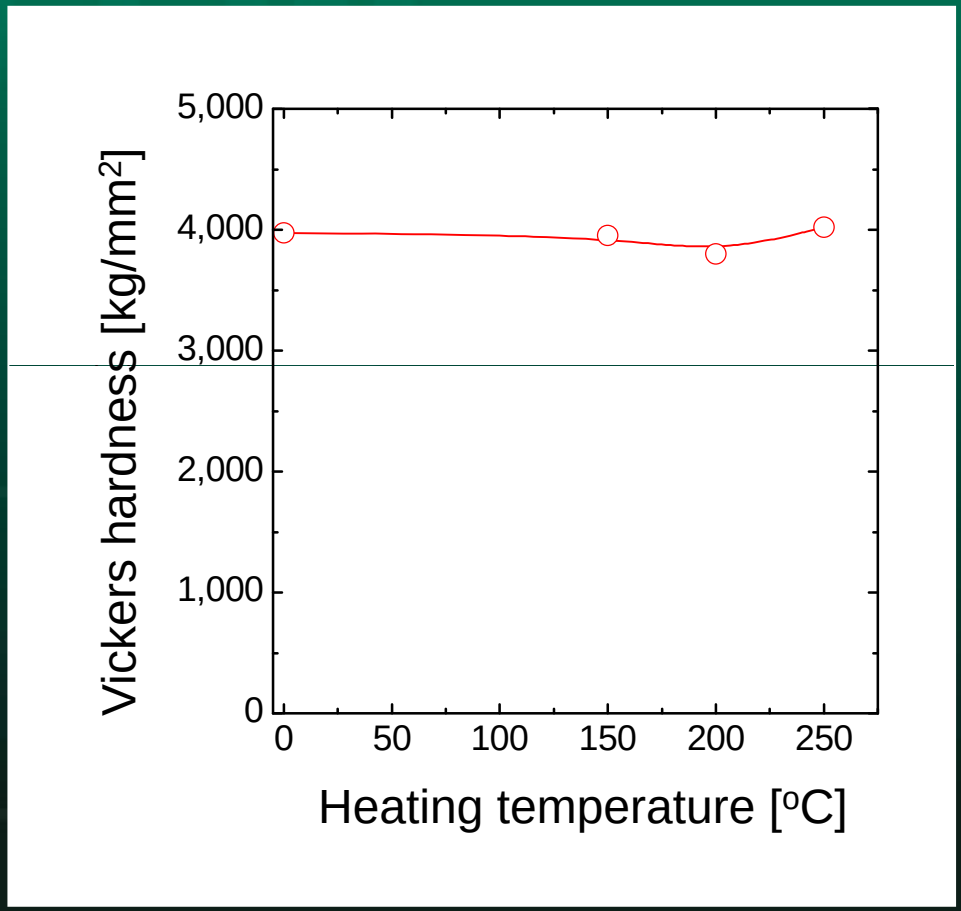
- **Contact**
  - We exhibit the SWTW Expo.
  - Booth No. 2

Reference of electrical conductivity

- Au = 2×10^{-6} ohm cm
- Cu = 2×10^{-6} ohm cm
- WC = 5×10^{-5} ohm cm
- Cr = 1×10^{-5} ohm cm
- Steel = 1×10^{-4} ohm cm
- PET film = 10^{16} ohm cm

Hardness is stable up to 250 °C

- **Heating test condition**
  - temperature: 150-250°C
  - Heating time: 2 hours
  - Heating environment: Air

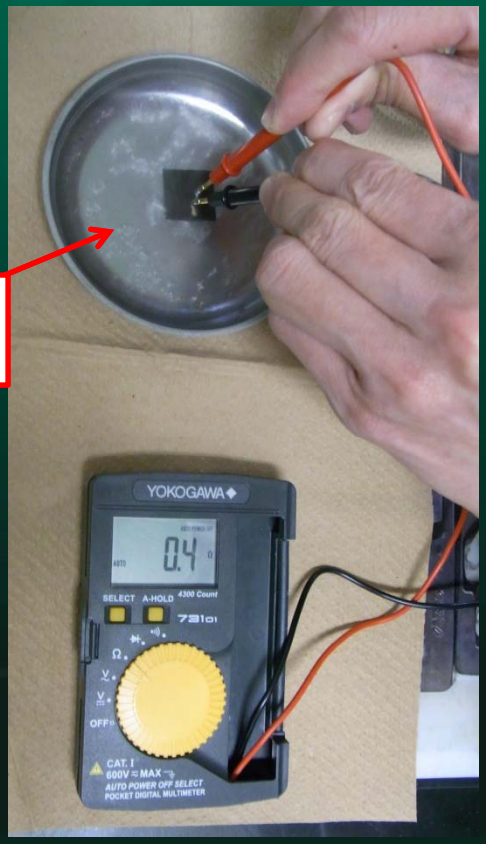


Stable resistivity at Low temperature

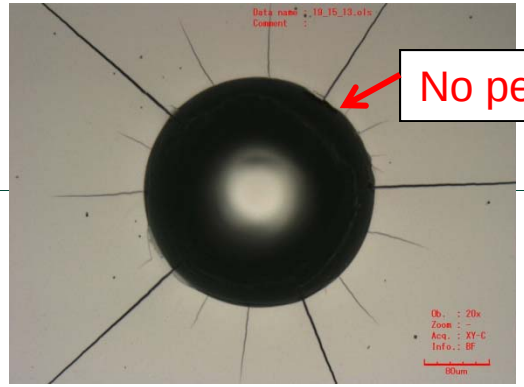
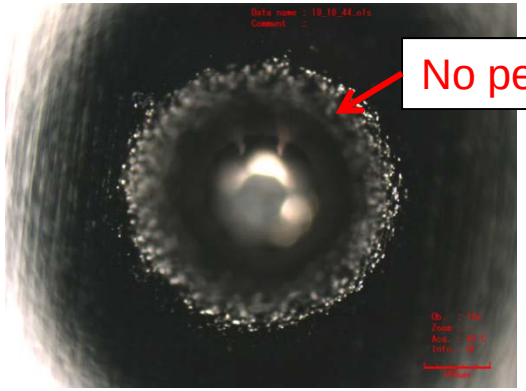
Resistivity@15°C= 0.3 ohm

Sample was dipped into Liquid N2(-196 °C).

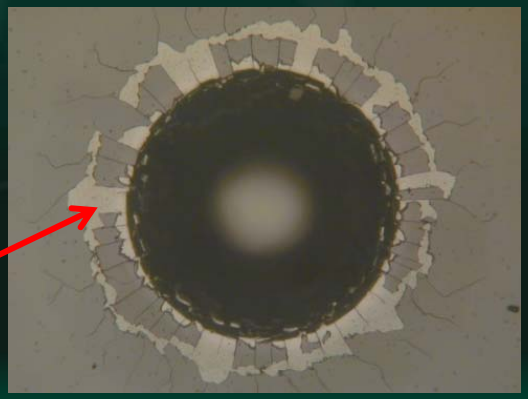
Resistivity@-196°C= 0.4 ohm



High adhesion of the film on the substrate

	The carbonaceous film (thickness: 1.0 um)
Substrate: WC	 No peeling
Substrate: Cu-Be	 No peeling

Reference: Low adhesion film



A table of the carbonaceous film properties

	The cabonaceous film
Hardness	Hv 4000 [kg/mm^2]
Thermal stability	250 ^{o}C
Process temp.	below 100℃
Contents of diamond elements	high
Density	high
Adhesion	Strong
Surface roughness	Ra < 1.0 [nm]
Element	Carbon+ Boron
Friction coefficient	0.1 (in air)
Transparency of infrared rays	transparent
Refractive index	2.30-2.35
Contact angle	80^{o}