

Multi-functional plasma polymer thin films fabricated by large area roll-to-roll sputtering process

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Multi-Functional Hydrophobic Coating



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❖ **Summary**



Introduction

Surface Functional Thin Film Coating

Camera Lens用 Coating



Display用 Coating



AF Coating



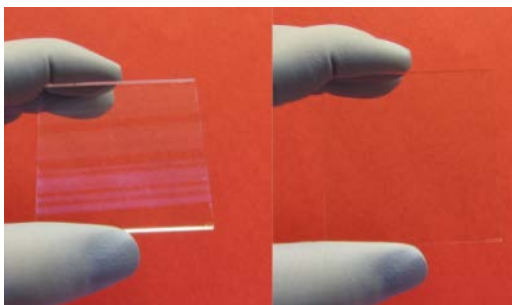
Low - E



Flexible Hard Coatings for OLED Lighting



AR Coating



Vitex Barrier film



Gorilla + Anti-bacteria





Introduction

Conventional Polymer Coating Process

Wet Coating Process



Evaporation Process



CVD Process



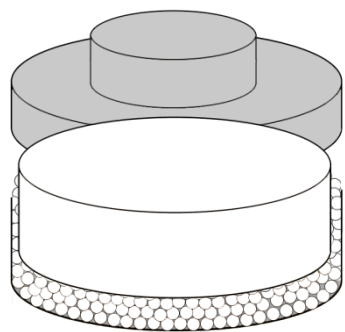
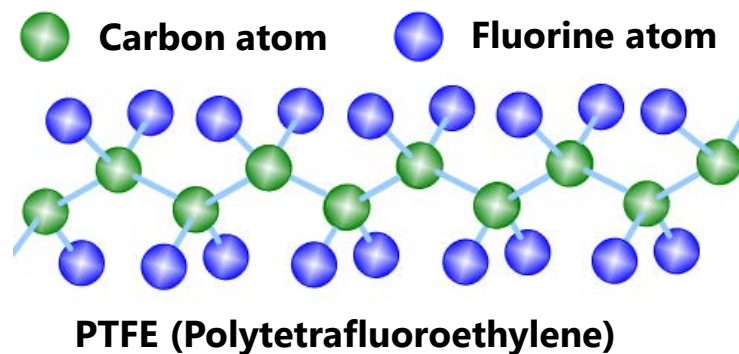
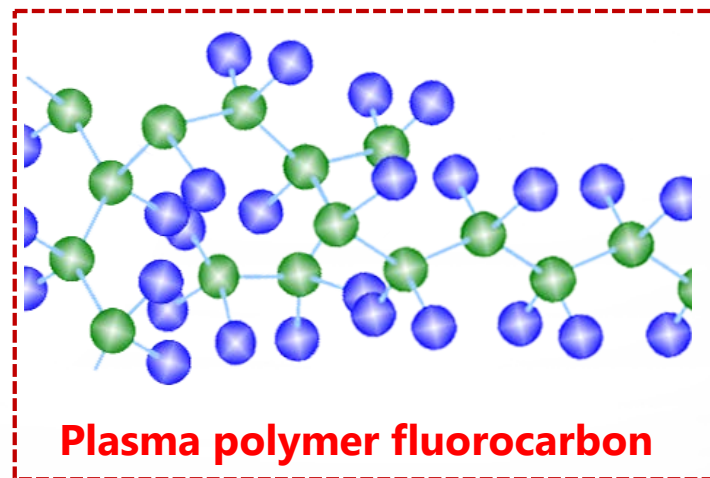
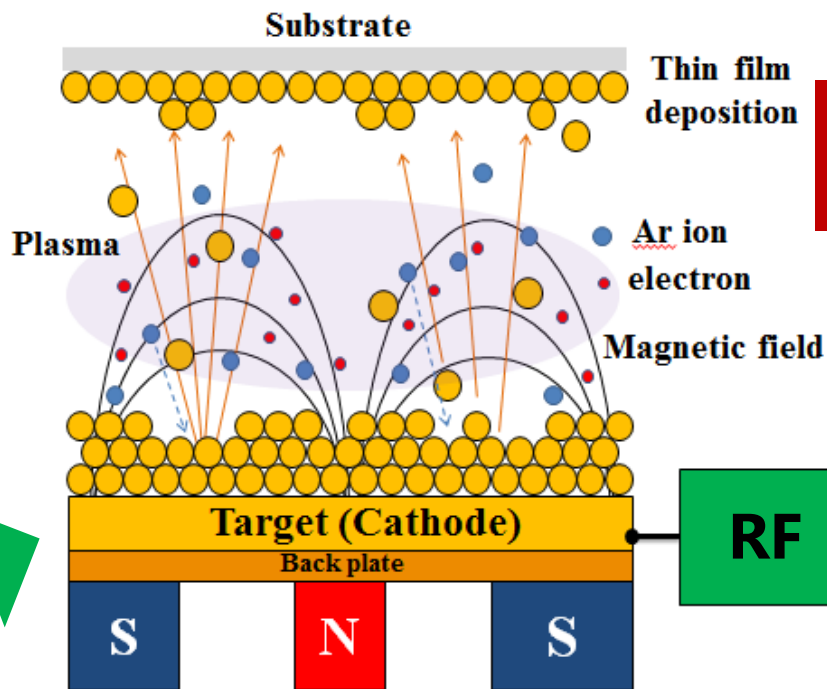
P2i perform
protect
improve





Introduction

Sputtering Process (Radio Frequency)



PTFE target

Press Molding



Introduction

Previous Reports

R. Harrop & P. J. Harrop, FRICTION OF SPUTTERED PTFE FILMS, *Thin Solid Films*, 3 (1969) 109-117

: First report on the RF-Sputtered PTFE thin film

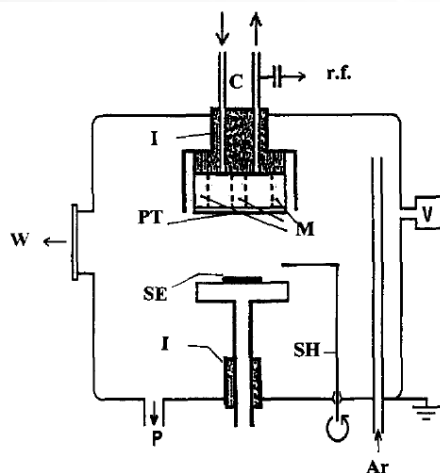
D.T. Morrison & T. Robertson, RF Sputtering of Plastics, *Thin Solid Films*, 15 (1973) 87-101

: RF sputtering of PTFE to obtain insulating layer for capacitor

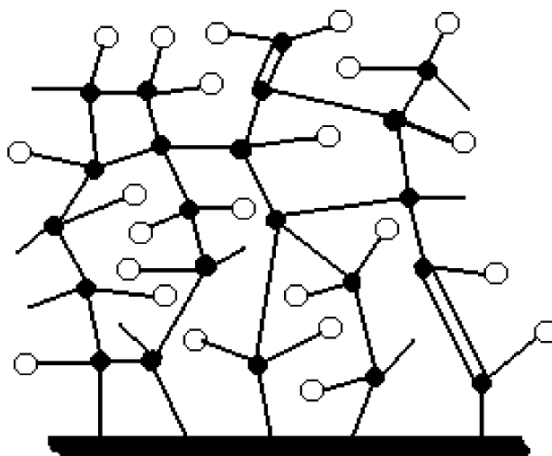
Hydek Biederman Group (Czech, Charles University)

: Studied plasma polymer thin film using various polymer targets such as PTFE, PE, PI, etc by RF sputtering process

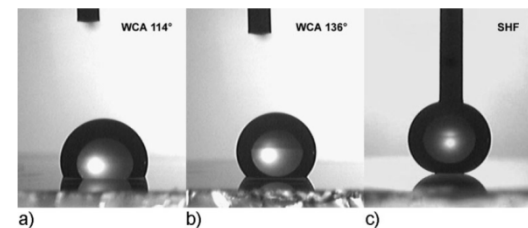
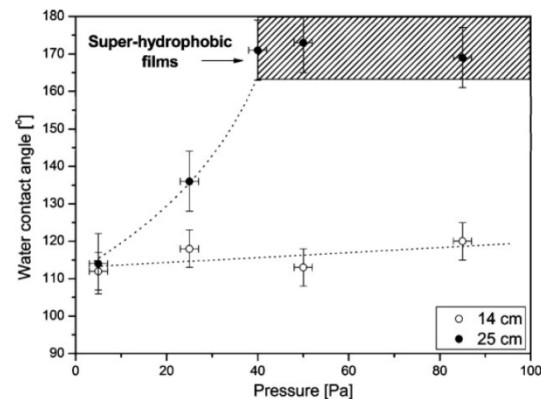
: Reported Superhydrophobic, Optical properties, multilayer, co-sputtering layer, etc. for over 40 years



Journal of Non-Crystalline Solids 218 (1997) 44-49



Vacuum 59 (2000) 594-599



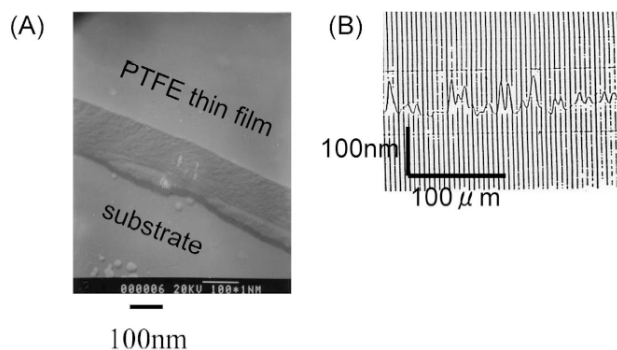


Introduction

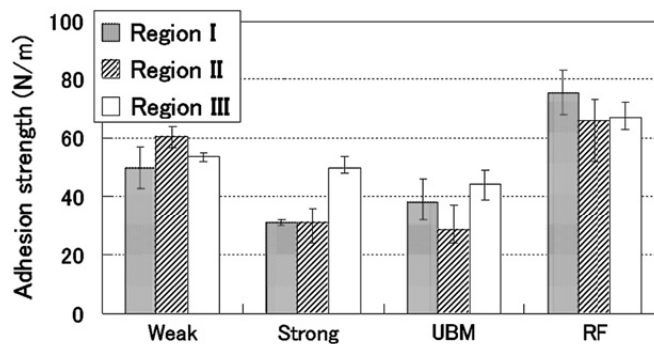
Previous Reports

S. Iwamori Group (Japan, Kanazawa University)

: Reported RF-Sputtered plasma polymer fluorocarbon thin films focused on the adhesion and tribological properties



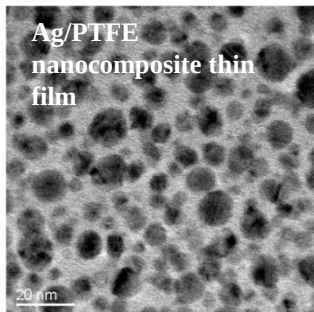
Journal of the Vacuum Society of Japan Vol. 50, No. 10 (2007)



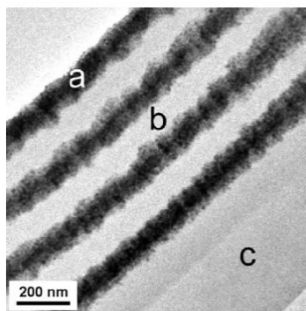
Vacuum 84 (2010) 592-596

F. Faupel Group (Germany, Kiel University)

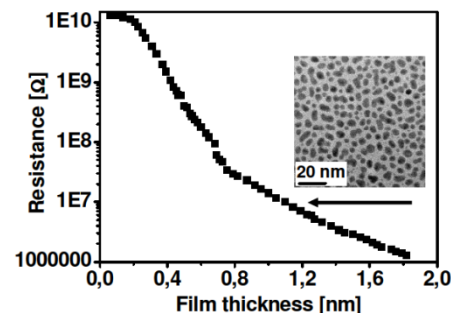
: Reported Co-Sputtered organic/metal composite fluorocarbon thin films using two RF sputtering cathodes



Nanotechnology 16 (2005) 1078-1082



Thin Solid Films 515 (2006) 801-804



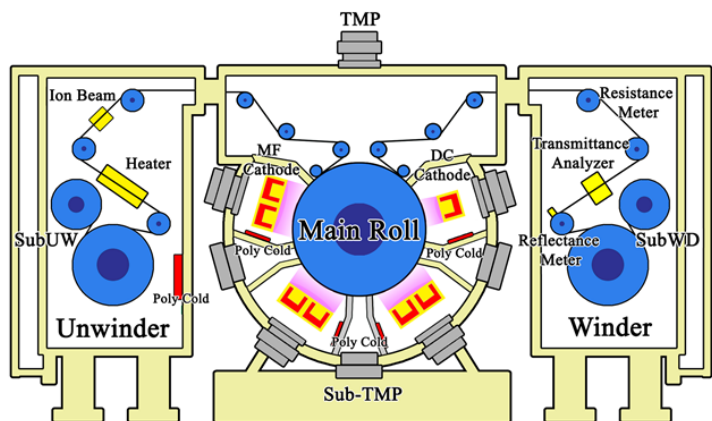
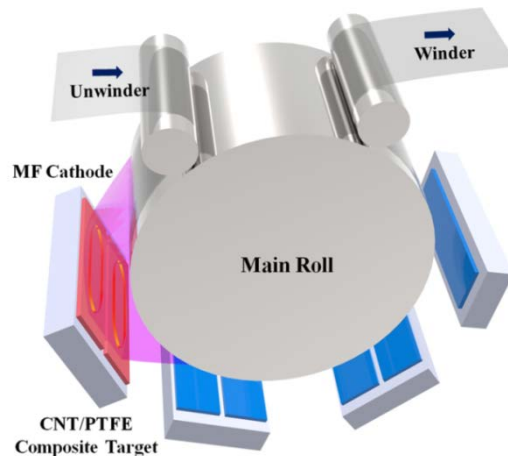
Journal of Physics: Conference Series 100 (2008) 052043



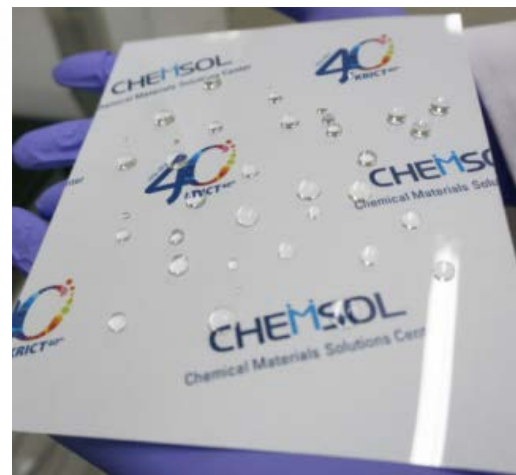
Roll-to-Roll Process

Large Area Deposition by pilot scale Roll-to-Roll Sputtering

- Composite Target : CNT 5 wt% / PTFE 95 wt%
- Target Size : 127 mm × 950 mm × 6mm
- Roll (Line) Speed : 1 m/min
- MF power : 3 kW
- Base/Working Pressure : 5×10^{-5} Pa / 4.85×10^{-1} Pa
- Pre-treatment : Heat treatment@300°C, Ar/O₂ Plasma Treatment
- Coating Length : > 100 m



Transmittance ~ 92%



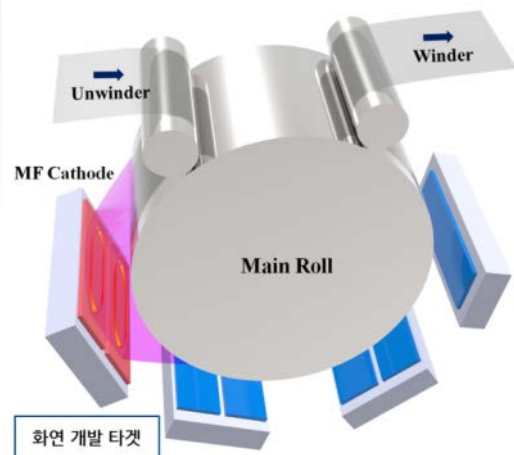
Film Thickness ~ 100 nm
Water Contact Angle ~ 115°



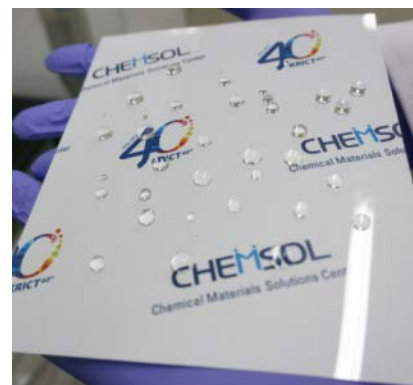
Roll-to-Roll Process

Multi-functional hydrophobic coating

R2R Sputter Process



MF & DC Sputtering Process

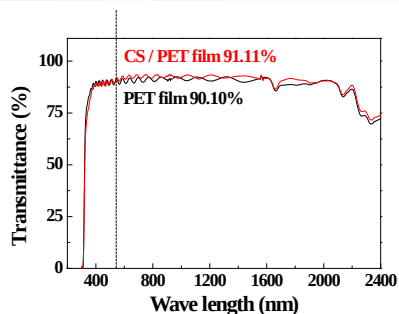




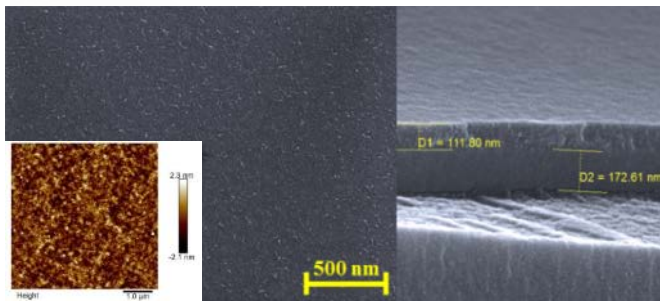
Sputtered Plasma Polymer **Strictly Confidential**

Fluorocarbon Nano-Thin Film Properties

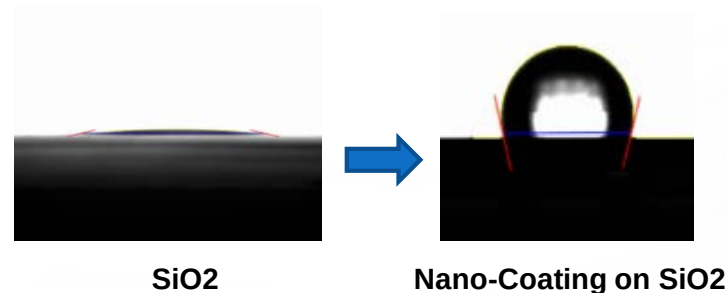
High transparency



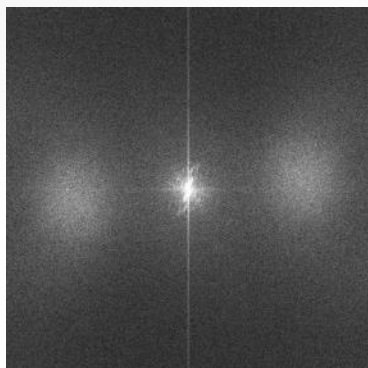
Smooth Surface



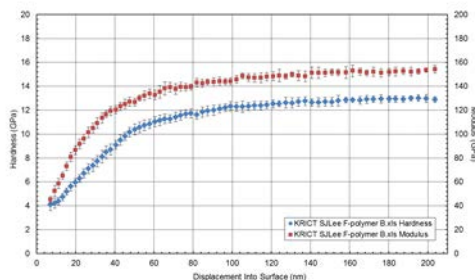
Hydrophobic & Oleophobic



Amorphous structure



Surface Hardness



1.5 ~ 7 GPa

Flexibility





Flexible & Hardness

Multi-functional hydrophobic coating

Bending Test



Twisting Test



Rolling Test



Sample #1
before bending

300nm

Sample #1
after 10000 cycles bending

300nm

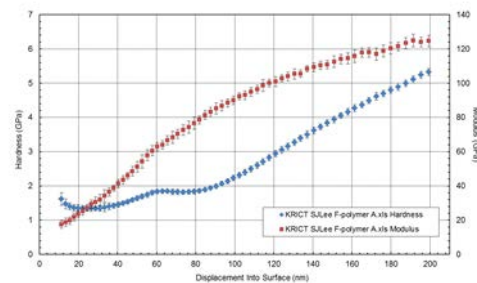
Sample #2
before bending

300nm

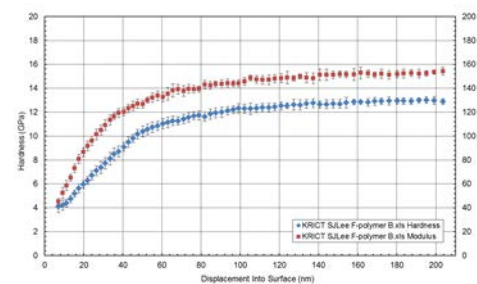
Sample #2
after 10000 cycles bending

300nm

No Crack!!



Surface Hardness
~ 1.4 GPa



Surface Hardness
~ 6.9 GPa



Substrates

Substrate : Glass, Film, Fabric, Metal, Paper etc

Nylon



[코팅 전]



[코팅 후]

Paper



[코팅 전]



[코팅 후]

PET Film

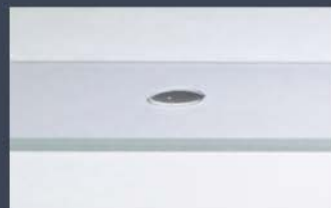


[코팅 전]



[코팅 후]

Glass



[코팅 전]



[코팅 후]

Polyester / Nylon (80:20)



[코팅 전]



[코팅 후]

Plastic



[코팅 후]

Metal



[코팅 후]



Applications

Various Applications of Sputtered Fluorocarbon Thin Films





Summary

Plasma Polymer Fluorocarbon Thin Films

- **CNT/PTFE composite targets show enough conductivities to generate plasma in Mid-Range Sputtering Process**
- **Sputtered fluorocarbon thin films exhibit high optical transparency, hydrophobicity, surface hardness simultaneously**
- **Sputtered fluorocarbon thin film shows excellent mechanical flexibility because of amorphous structure.**
- **Possible to make Flexible-High Hardness, Hydrophobic, Transparent Nano-Thin Film for flexible/rollable/foldable display devices.**
- **We successfully demonstrate large area fluorocarbon thin film using pilot scale roll-to-roll sputtering equipment.**



Thank you!!