



# News on DLC Coatings

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# Outline



- **Thick DLC coating**
- **Coating DLC with Copper**
- **DLC Photocathode**
- **Large Volume Resistivity DLC on Metal**
- **Affect of Heating and Pressure**

# Thick DLC Coating



“Thick” means around  $1\mu\text{m}$

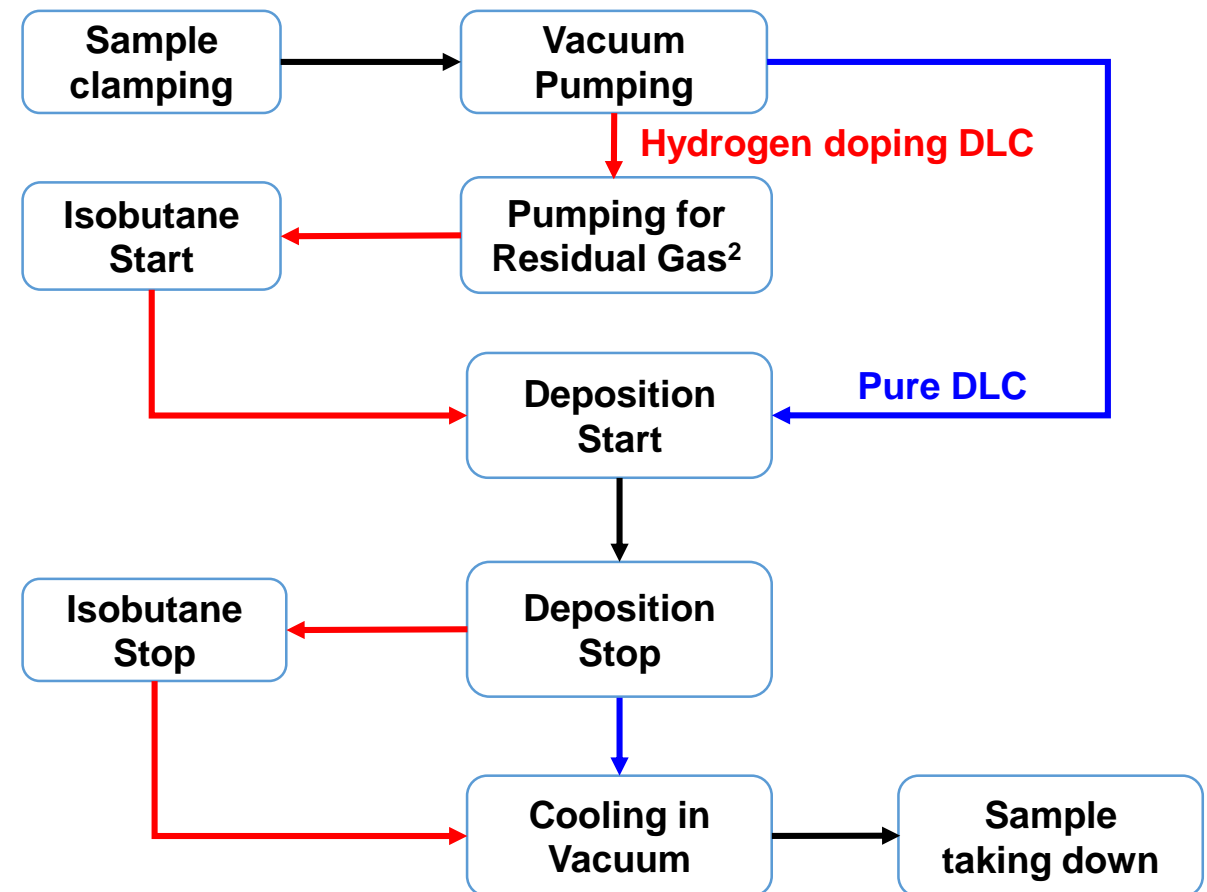
## Why do we coat thick DLC?

1. Better uniformity of thickness/surface resistivity ;
2. Higher mechanical strength;
3. Stronger blocking ability to the liquid;

## How do we coat thick DLC?

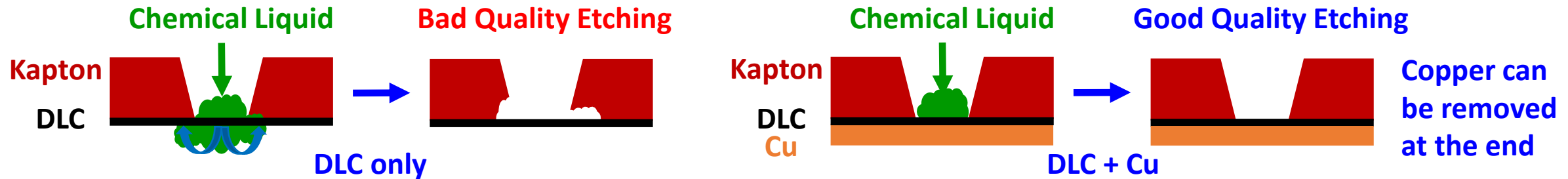
1. More hydrogen doped, higher surface resistivity ;
2. Large thickness, lower surface resistivity;
3. Longer deposition time, larger thickness of the DLC

## Flow Chart of the DLC Coating



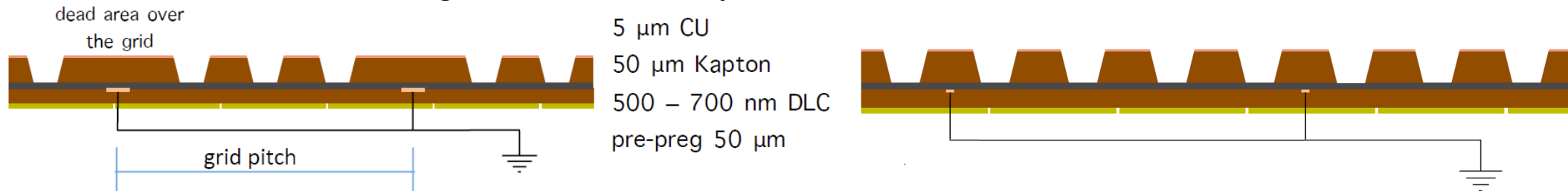
# Potentialities of Coating DLC with Copper

## 1. Improving the quality of current MPGDs



## 2. Allowing printed circuit layouts on DLC thus realizing complex functions

Figures come from the presentation of G. Bencivenni



Conductive strips using screen-printing cause dead areas

DLC + Cu allow to use photolithography to greatly reduce dead areas

Coating DLC with copper can expand the capacity and applications of the MPGDs and open a way for new MPGD architectures

# Work Plan for DLC photocathode



- Make DLC films with different thicknesses (from 5nm – 30nm)
- Investigate how to make “graphite-like” carbon in a controlled way
- Make DLC photocathode ( MgF<sub>2</sub> + Cr + DLC ) with different graphite content
- Test quantum efficiency for these samples
- Get theoretical guidance material and electro-optics experts

# Affect of heating



## Motivation:

To find out the intrinsic reason of the surface resistivity changing caused by heating.

	Resistivity 1	Temperature	Time	Gas	Surface Resistivity 2
1	300M $\Omega$ /□	300°C	120min	Air	120M $\Omega$ /□
2	200M $\Omega$ /□	300°C	120min	Air	100M $\Omega$ /□
3	100M $\Omega$ /□	300°C	120min	Argon	30M $\Omega$ /□
4	90M $\Omega$ /□	300°C	120min	Nitrogen	20M $\Omega$ /□
5	150M $\Omega$ /□	300°C	60min	Air	50M $\Omega$ /□
6	140M $\Omega$ /□	300°C	60min	Air	50M $\Omega$ /□
7	250M $\Omega$ /□	300°C	1050min	Air	93M $\Omega$ /□
8	30M $\Omega$ /□	300°C	1050min	Air	11M $\Omega$ /□
9	140M $\Omega$ /□	300°C	1050min	Air	64M $\Omega$ /□
10	50M $\Omega$ /□	200°C	780min	Air	40M $\Omega$ /□

Long term heating should count the effect of surface resistivity increasing by DLC itself.

Surface resistivity of DLC changed by heating is observed, **but we didn't find the rules yet, we need well arranged systematical work to understand it.**

# Affect of pressure



## Motivation:

To understand how does the press gluing process ( $10 \sim 20\text{kg/cm}^2$ ) during the detector manufacture change the surface resistivity of DLC.



Press Machine



$1\text{cm} \times 1.5\text{cm}$  sample  
 $274\text{M}\Omega/\square$



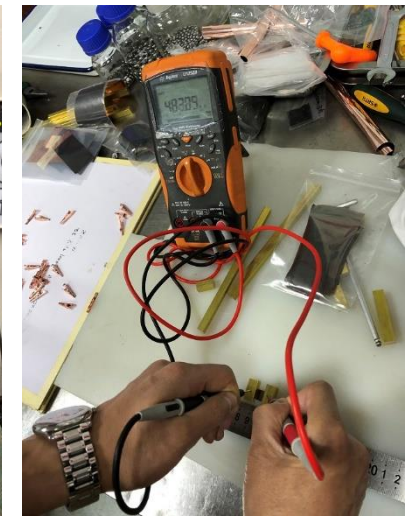
Put the sample in  
the steel mould



Put the sample in  
the steel model



$20\text{kg/cm}^2$ ,  $180\text{ }^\circ\text{C}$



Take out after 10h  
 $483\text{M}\Omega/\square$

- The pressure process can really change the surface resistivity of the DLC;
- It seems that I get an opposite result with what we observed from the  $\mu\text{RWELL}$  detectors;
- Maybe we have to do systematical test by using the device in Rui's workshop;

# Summary and Outlook



- DLC is a potential material for the applications in MPGD area;
- “DLC + Cu” technique and DLC photocathode should have the highest priority;
- We need scientists of material science and Nanotechnology to join us;
- Control the DLC in next years by teamwork;

**Thanks**

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Giovanni Bencivenni

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