



核数据重点实验室

GEM Foil at CIAE

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The progress of GEM Foil at CIAE

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Next step



Team members

- 2 Professors: Shuhua Zhou, Xiaomei Li
- 2 Associate Professors: Jing Zhou, Shouyang Hu
- 5 Graduated Student: Li Ye, Chao Shan, Siyu Jian, Xinglong Li and Hao Liang

Theoretical Collaborators at CIAE

Prof. Hanxin He, Prof. Benhao Sa, and Prof. Yuliang Yan

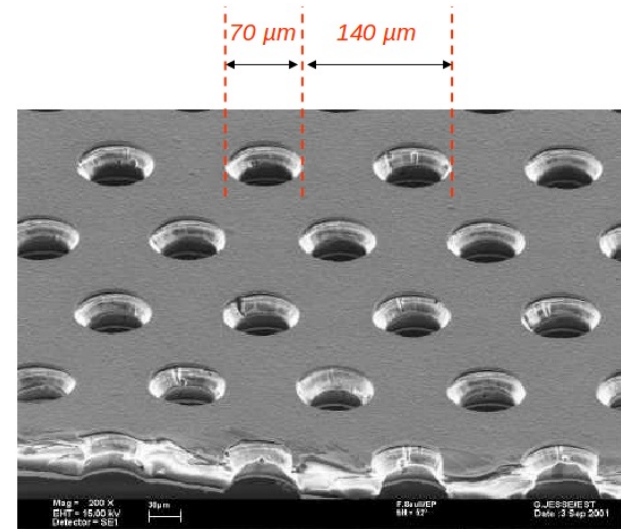


The Progress of GEM Foil at CIAE

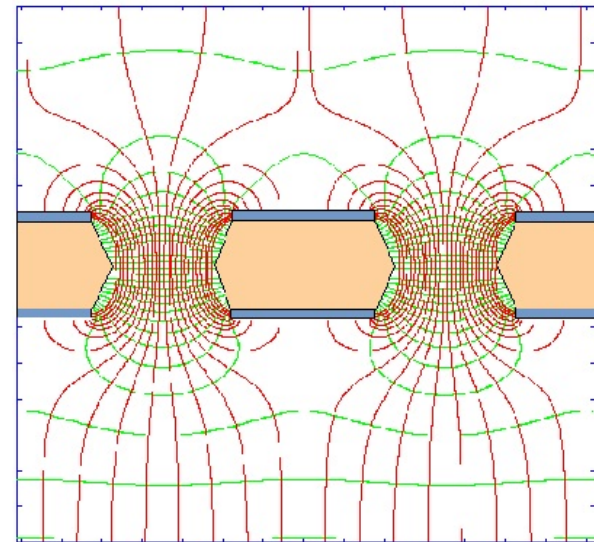


GEM Foil Structure

1. Typical GEM Foil has 3 layers, two $5\mu\text{m}$ thick copper foils and one $50\mu\text{m}$ thick kapton foil in the middle.
2. Diameter of the hole is $70\mu\text{m}$, and the distance between them is $140\mu\text{m}$.
3. Apply electric voltages on the two copper layers.
4. Electric Field is very strong in the hole area, and weak outside the hole area.

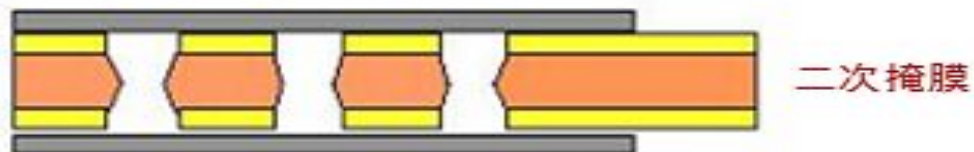
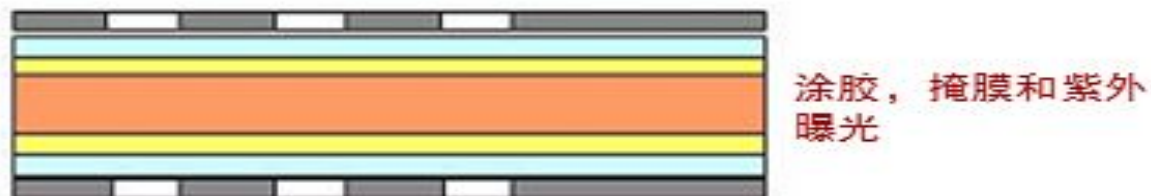
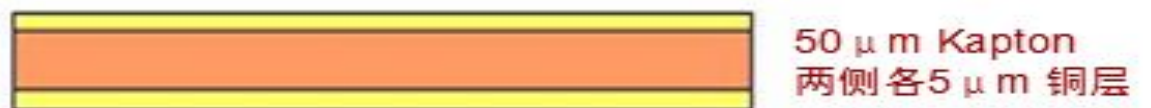


GEM Foil



GEM Field

The Procedure of GEM Foil

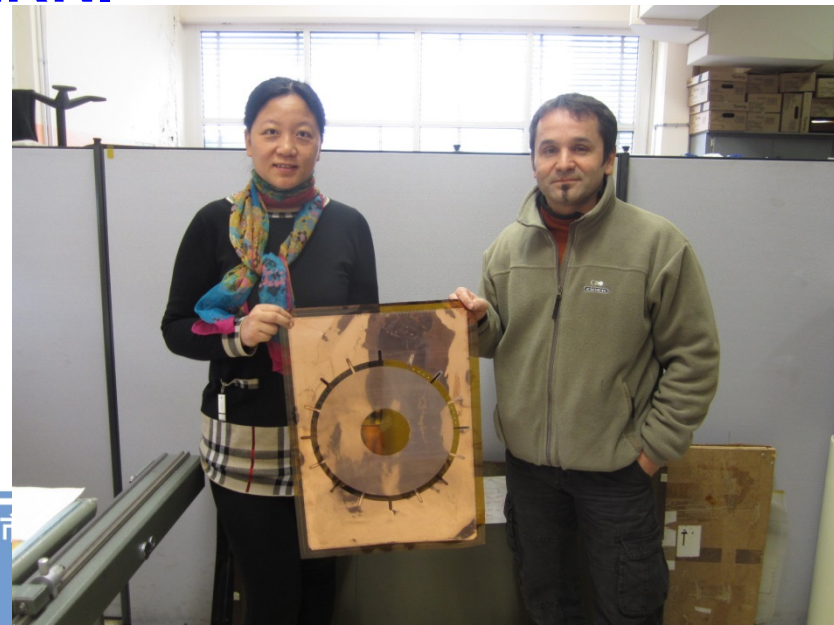


工艺流程

GEM License and Training

CIAE has signed officially the LICENSE AGREEMENT FOR MANUFACTURING AND COMMERCIALISATION OF GEM FOILS AND GEM-BASED PRODUCTS with CERN.

I took a training for GEM foil at CERN.



Clean Room



The cleanrooms at China Institute of Atomic Energy are ISO Class 6.



Photolithography Room Construction At CIAE

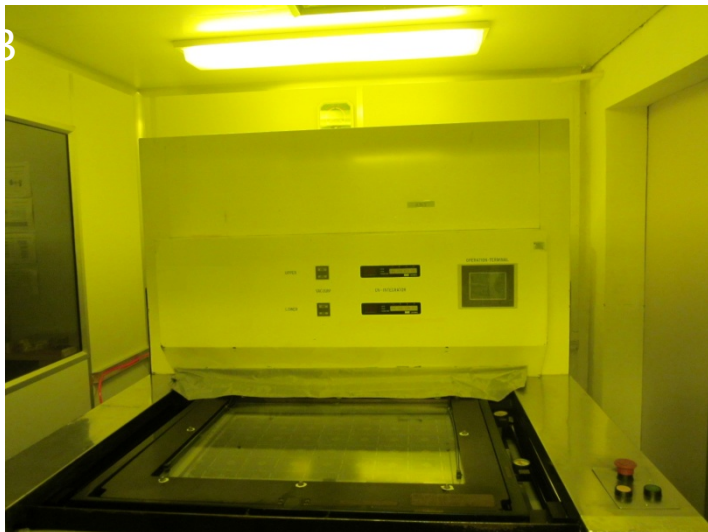


The Equipments for Lamination and Exposure of Dry Film Photoresist



Lamination and exposure of dry film photoresist are the most important and difficult steps for GEM foil production.

We have established a yellow light zone, Hot Roll Lamination (HRL) machine and Exposure system.

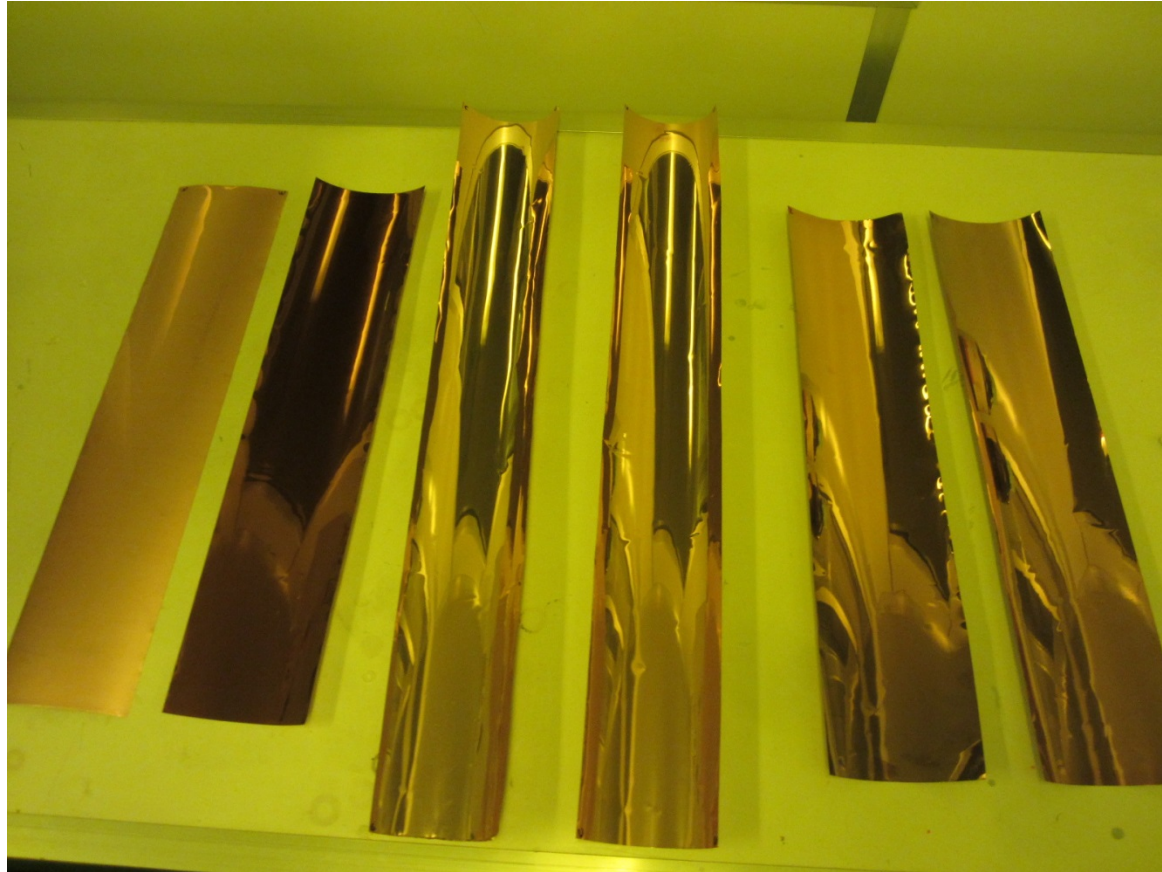


We invited a senior engineer from a famous electronic factory to CIAE and taught the PCB technology.

Etching Room Construction

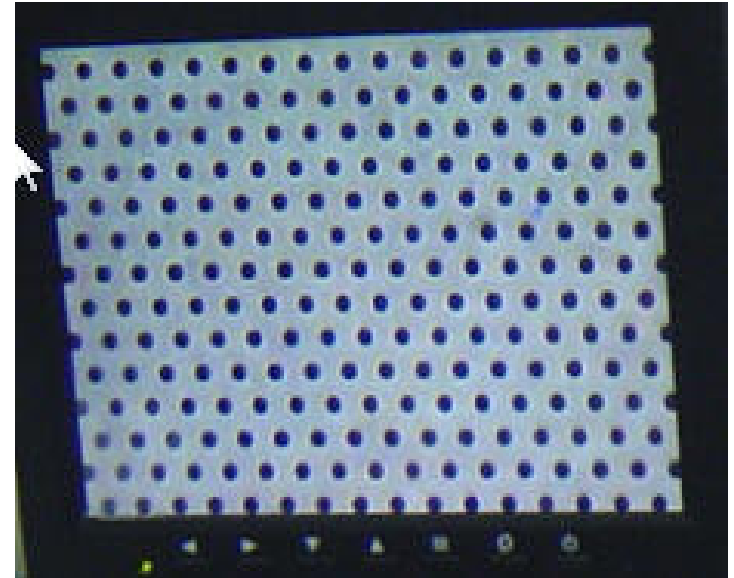
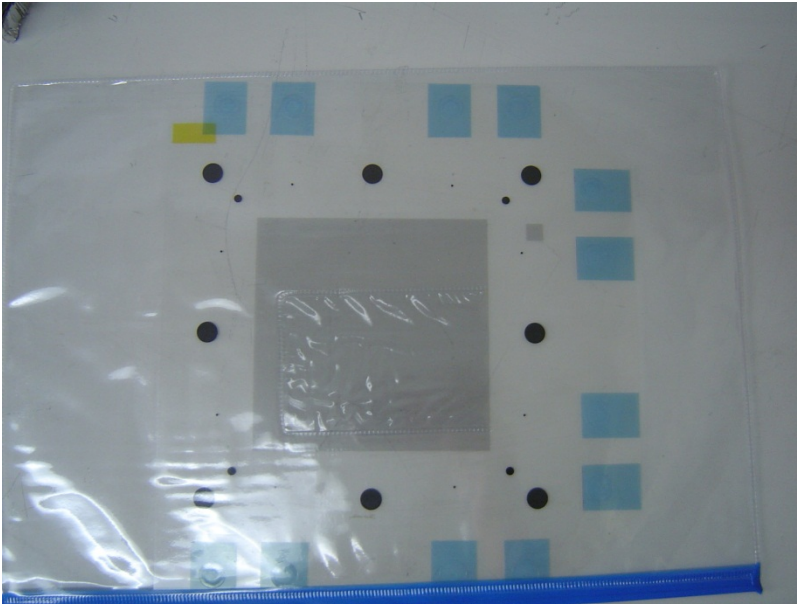


The Preparation of Raw Foils



Thanks a lot for the support of USTC, IHEP and Washington University .
We can compare the differences in GEM foil made by different raw materials.

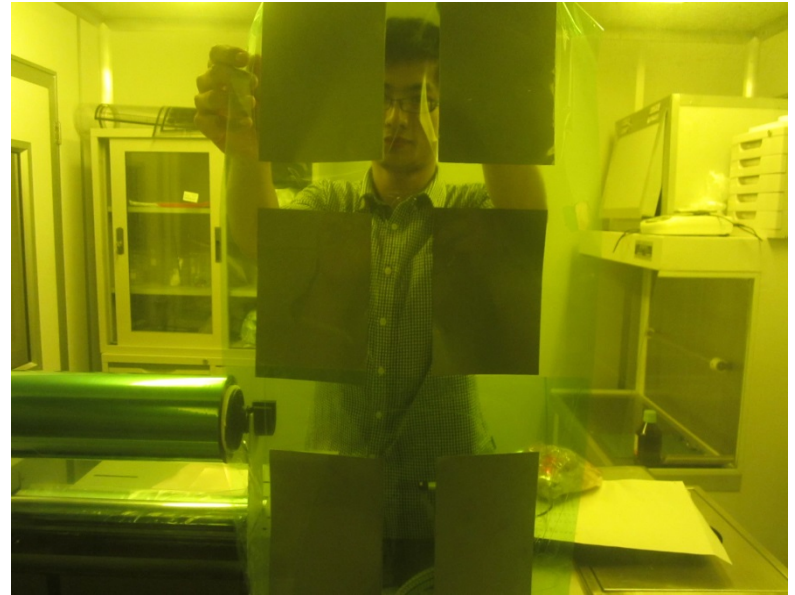
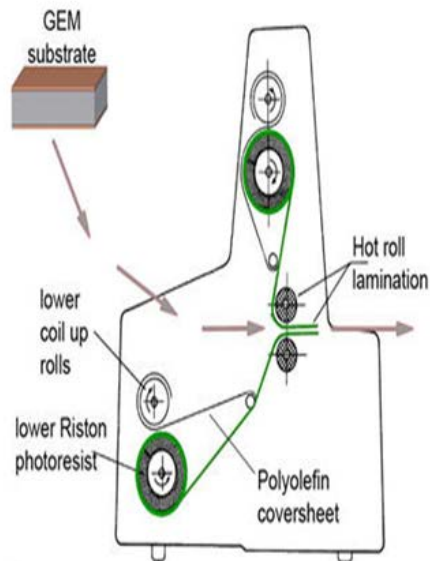
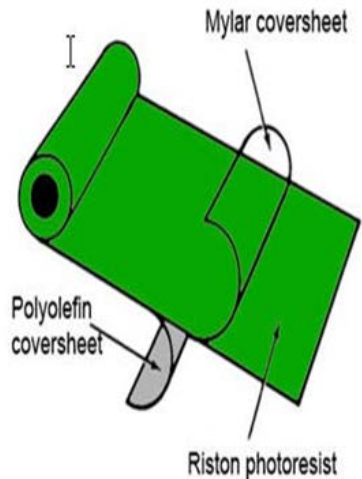
GEM Photo Mask Plate



The copies of the photo-mask are done by photolithographic techniques and can be reproduced multiple times.

Lamination of Dry Film Photoresist

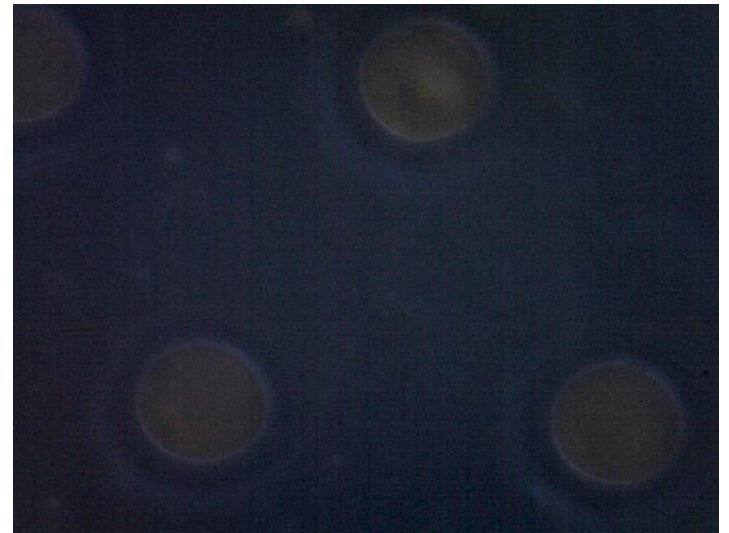
The photoresist is sandwiched between an inner polyolefin cover sheet and an outer Mylar protective layer.



Exposure of Dry Film Photoresist

We use negative photoresist for GEM image transfer, unexposed areas are relatively unchanged and easily washed out by solvents during the development.

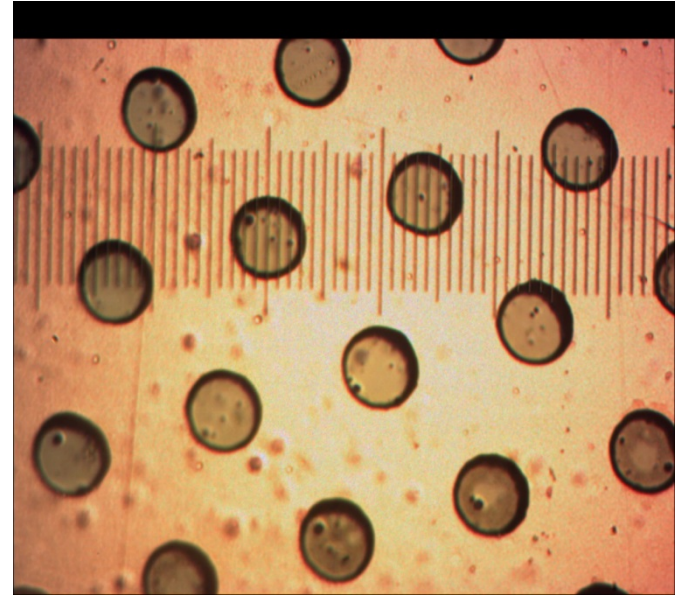
To obtain an identical copy of the photo-mask to the photoresist, vertical sidewalls in the resist are important.



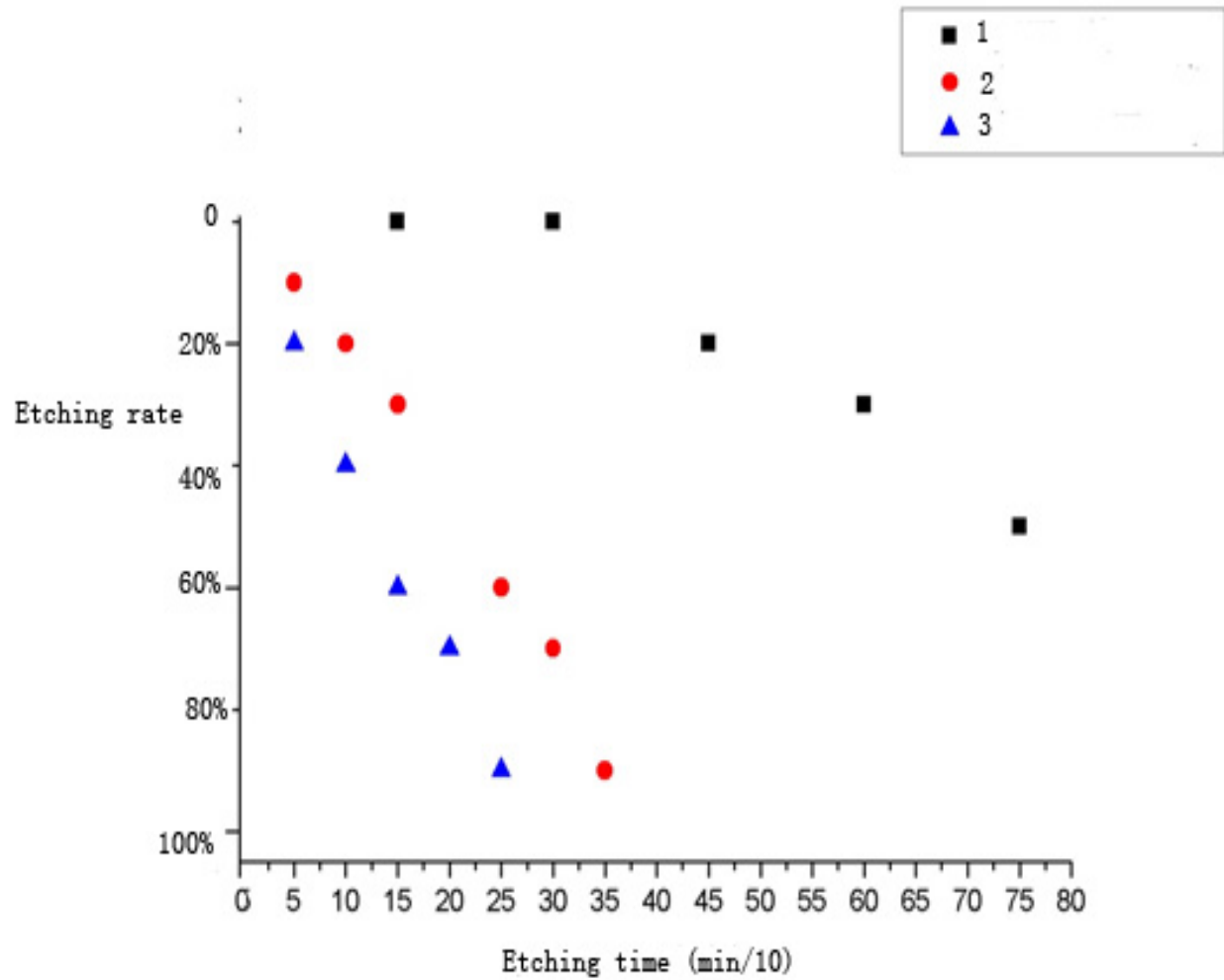
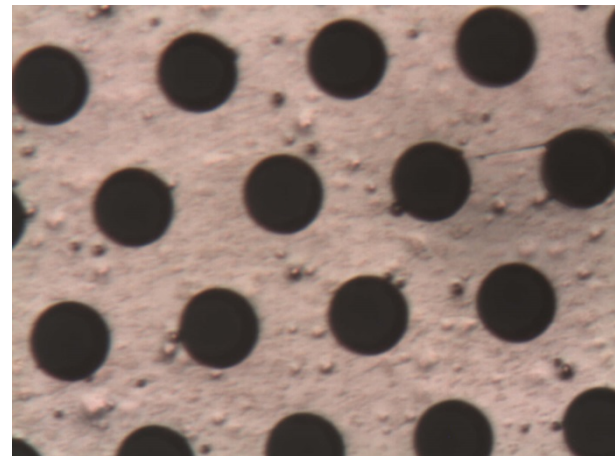
We can observe the image transfer with good accuracy.

Copper Etching

- All holes were made
- The size of the hole is 70um as expected

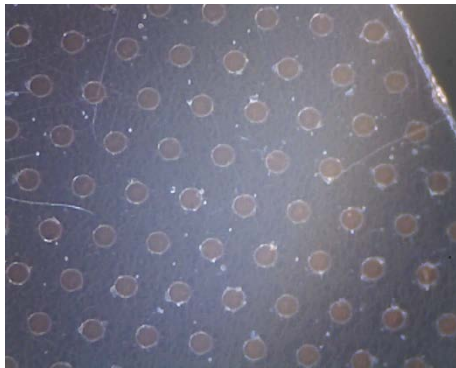


Kapton Etching



Comparison of Foils Made in Different Conditions

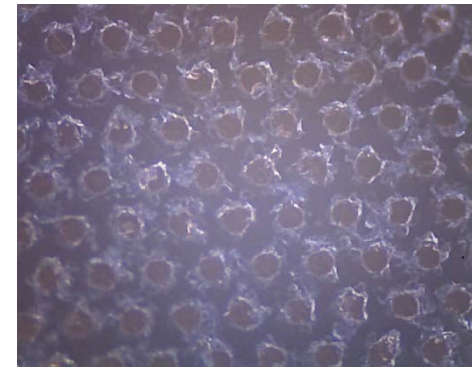
Insufficient development



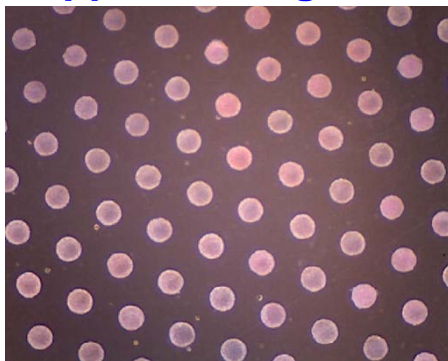
Good development



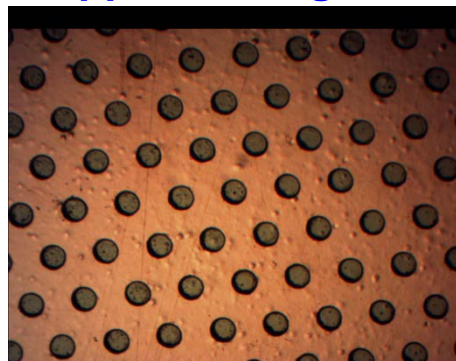
Excessive development



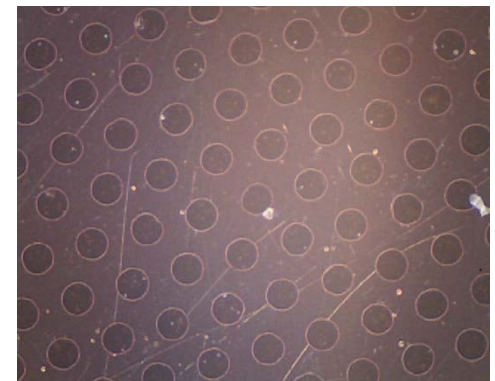
Insufficient copper etching



Good copper etching



Excessive copper etching



Comparison of Different Foils

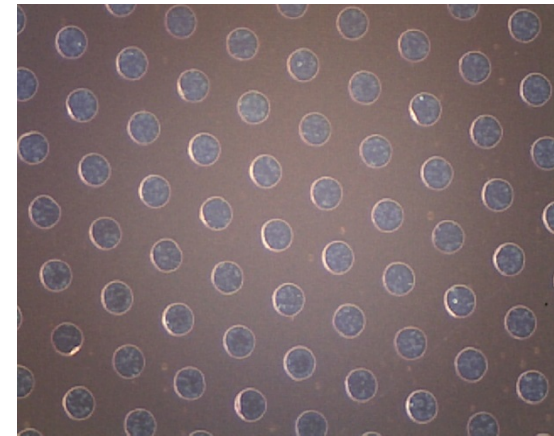
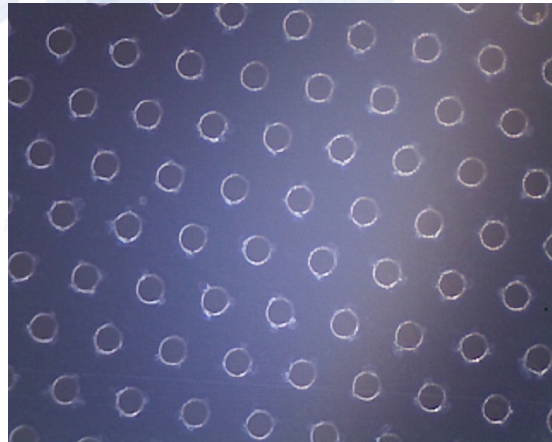
The results are very nice

foil
Source

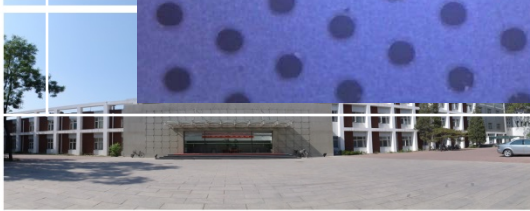
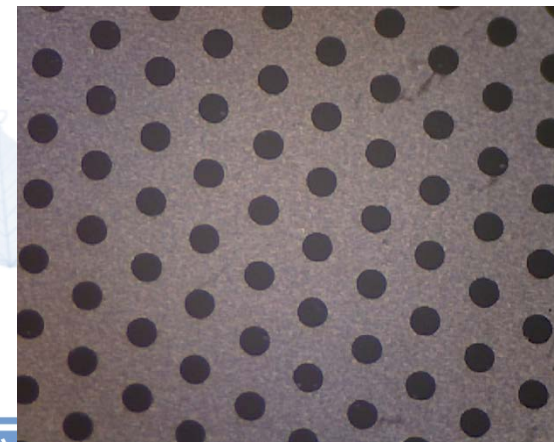
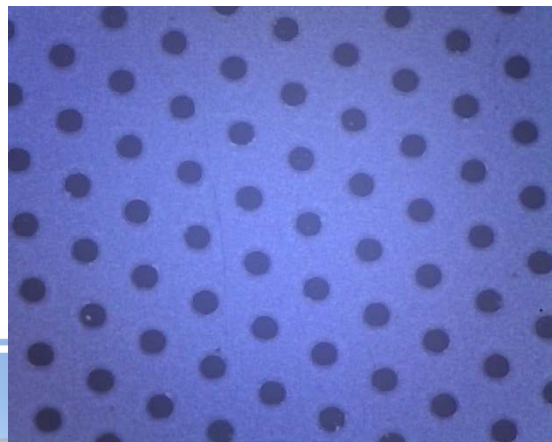
After Copper foil etching

After photoresist removed

Raw
foil
from
CERN

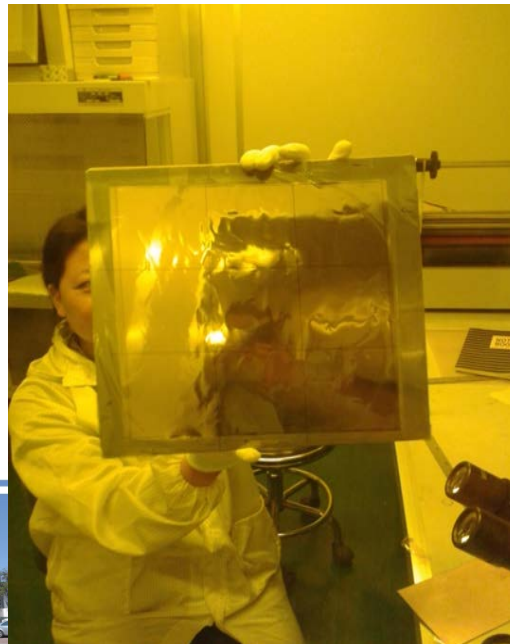


Raw
foil
from
USA

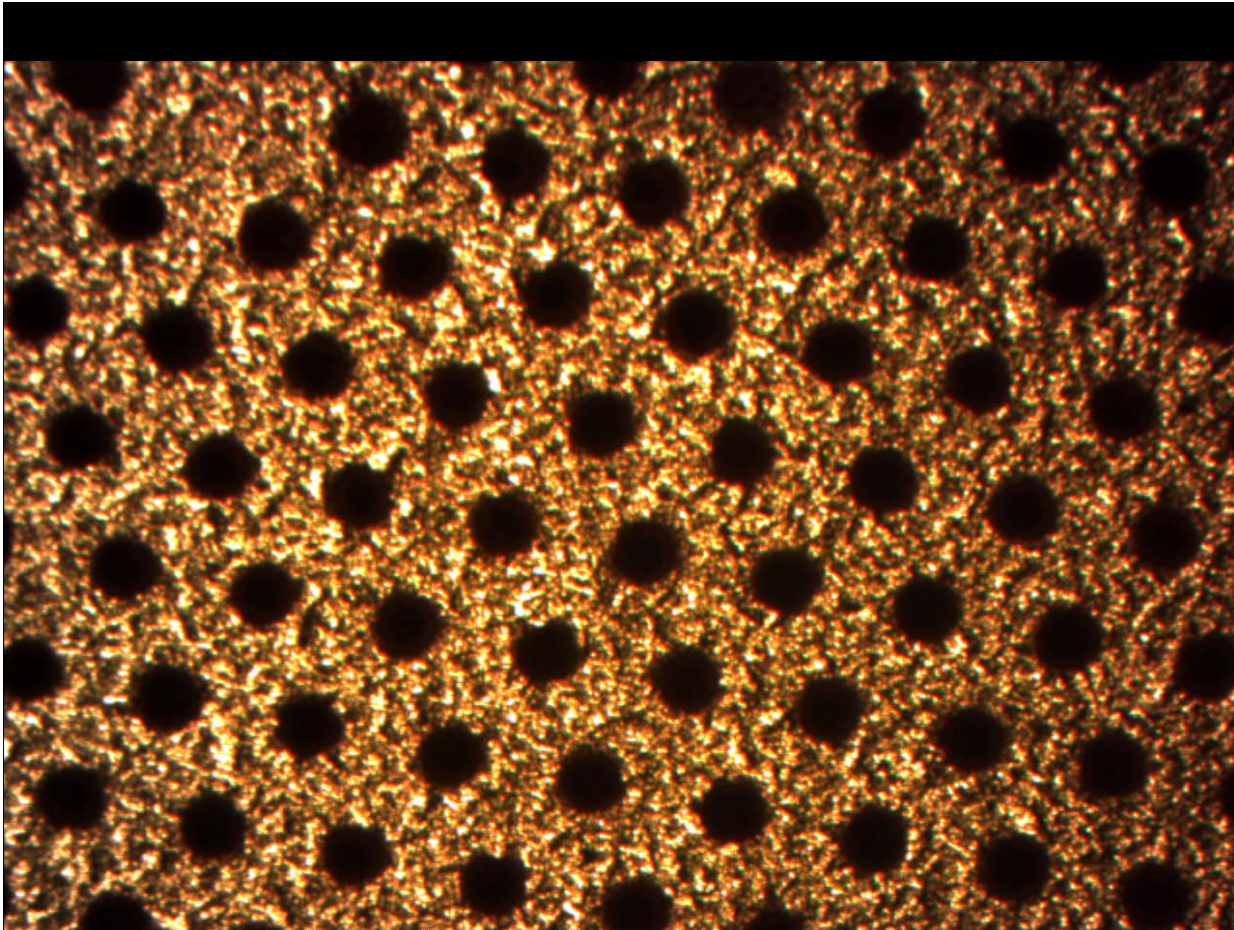


30cm*30cm GEM Foil

- The 30cm*30cm GEM foils were made successfully.
- double-mask method was used.
- We did more than 2000 samples before reaching this result.
- Sometimes the alignments of top and bottom masks were not perfect especially for large GEM foil. We are upgrading our alignment system.



Thick GEM Foil



Next Step

- Upgrading the current alignment system
- GEM foil R&D by single mask technology



Thank You !

