Nanopatterning and FET-Rectifying of Multilayer MoS_2 through Femtosecond Laser Micromachining

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Content

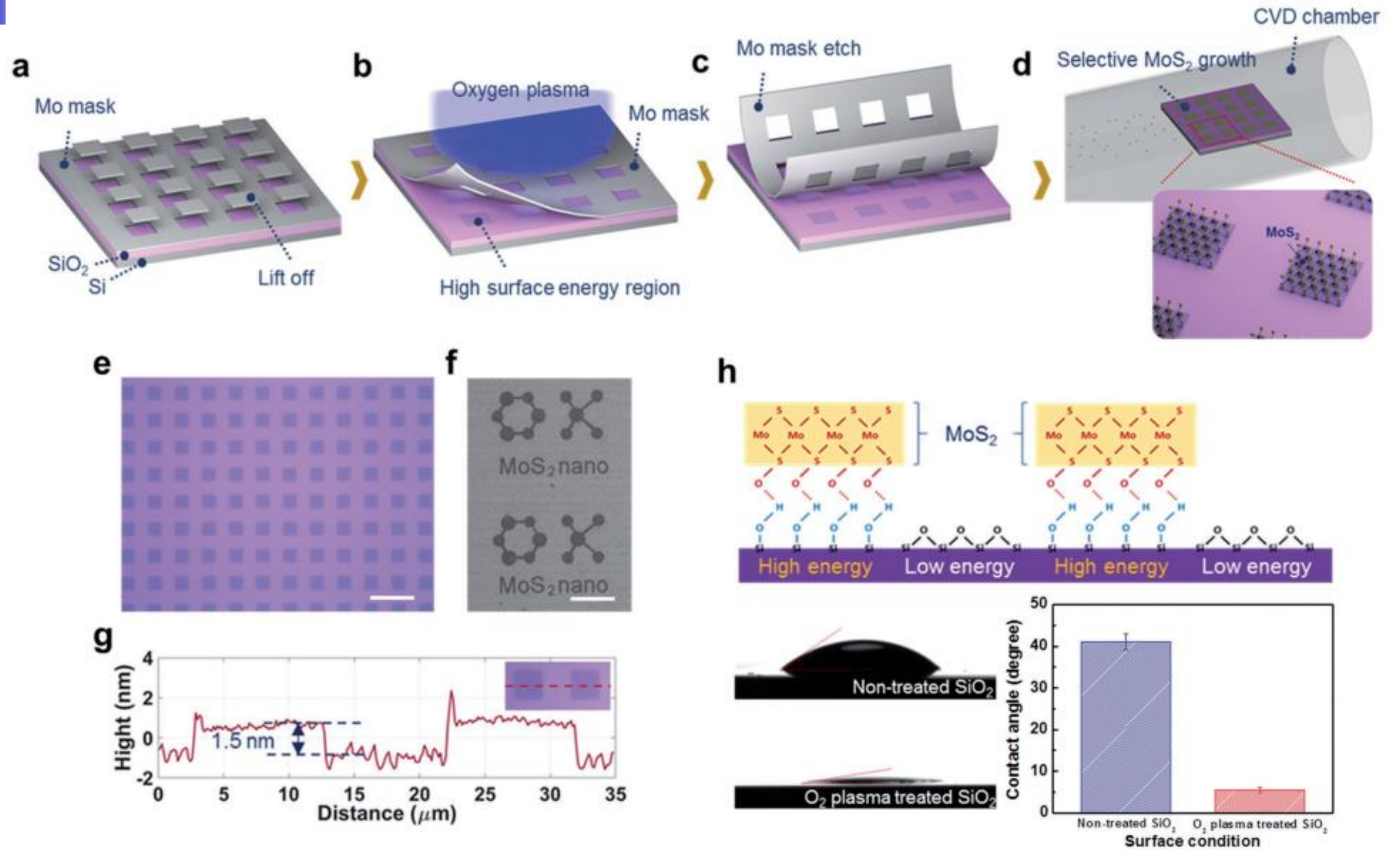
Literature exhibition

Experiment results

Future plans

Literature 1

Schematic outline of the MoS_2 growth patterning procedure.



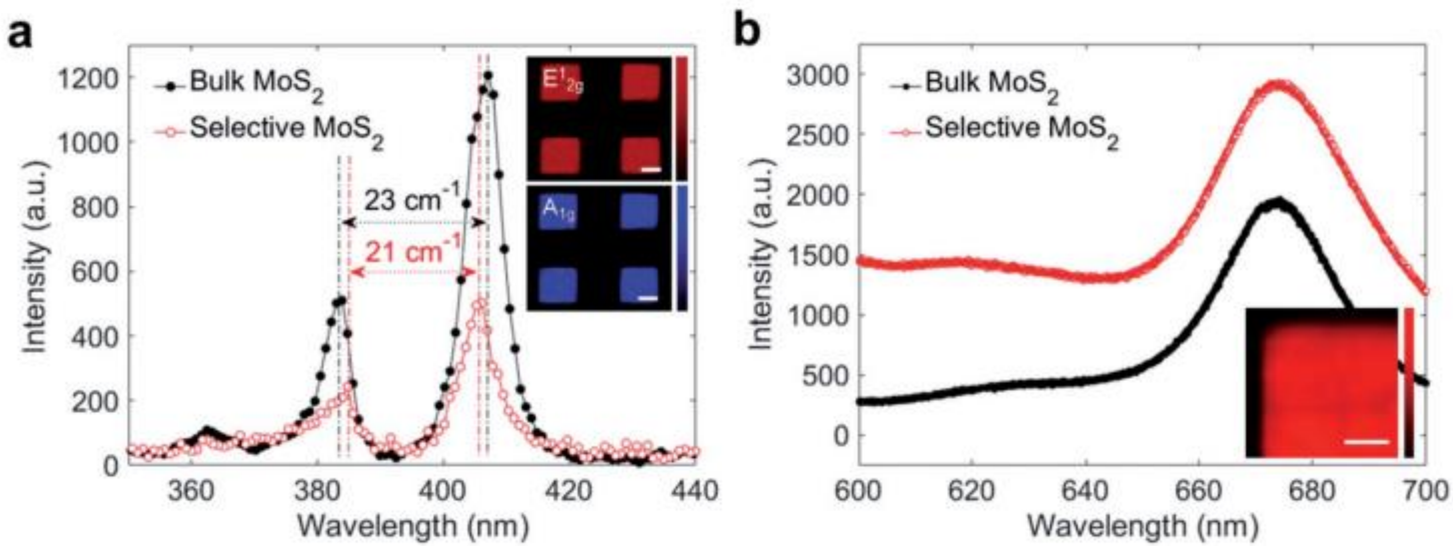
MoS_2 size: 10 × 10 μm², the scale bar is 33 μm. **Pattern: the scale bar is 80 μm**

O2 plasma is applied→Si bonds are broken→O and H bonds to some dangling bonds→imbalance of surface bonding increases the surface energy

Small **2017**, 1702256

Literature 1

Raman and PL spectra of bulk and selective MoS_2.



Small **2017**, 1702256

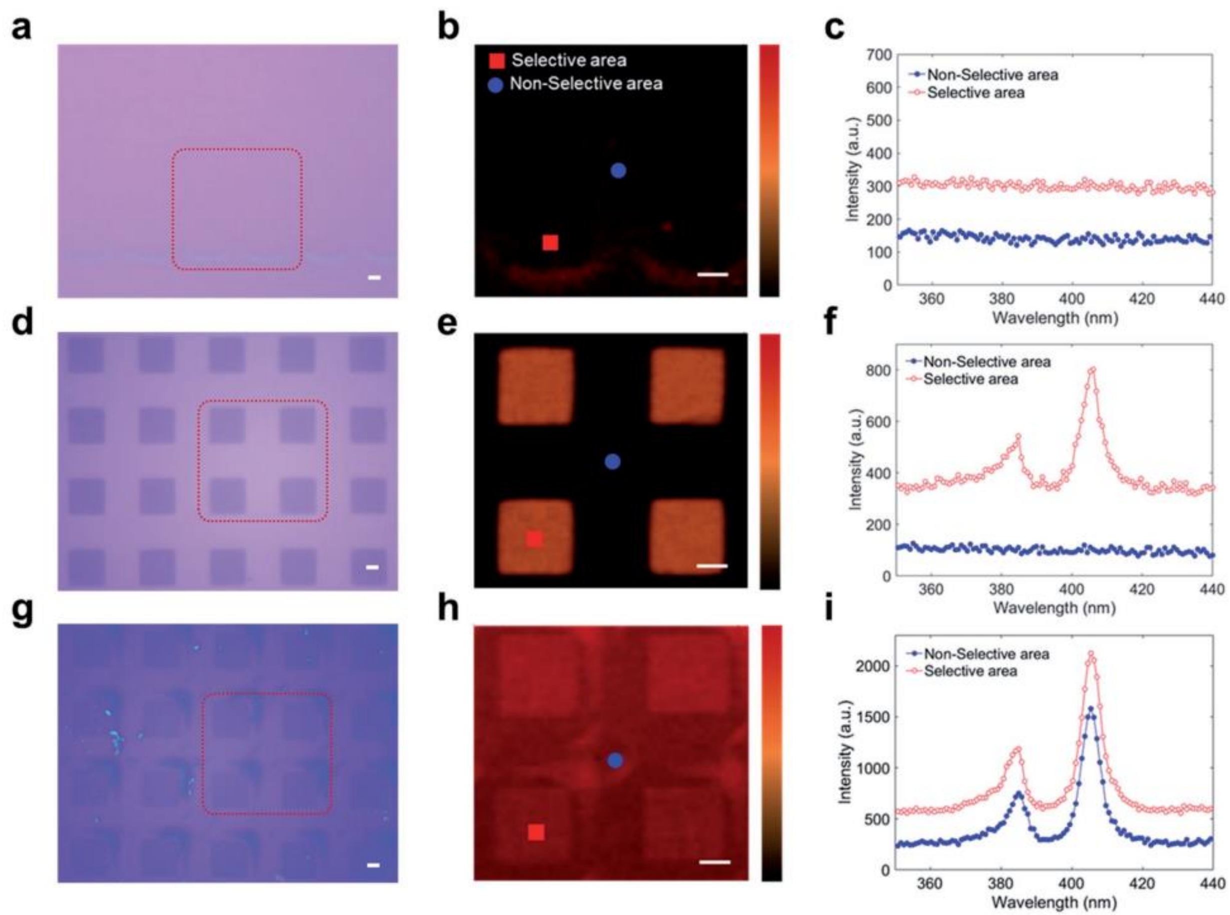
Literature 1

Optimization of the selective growth conditions with changing quantities of the MoO_3 powder.

Using 0.1 mg of MoO_3 powder

Using 0.5 mg of MoO_3 powder

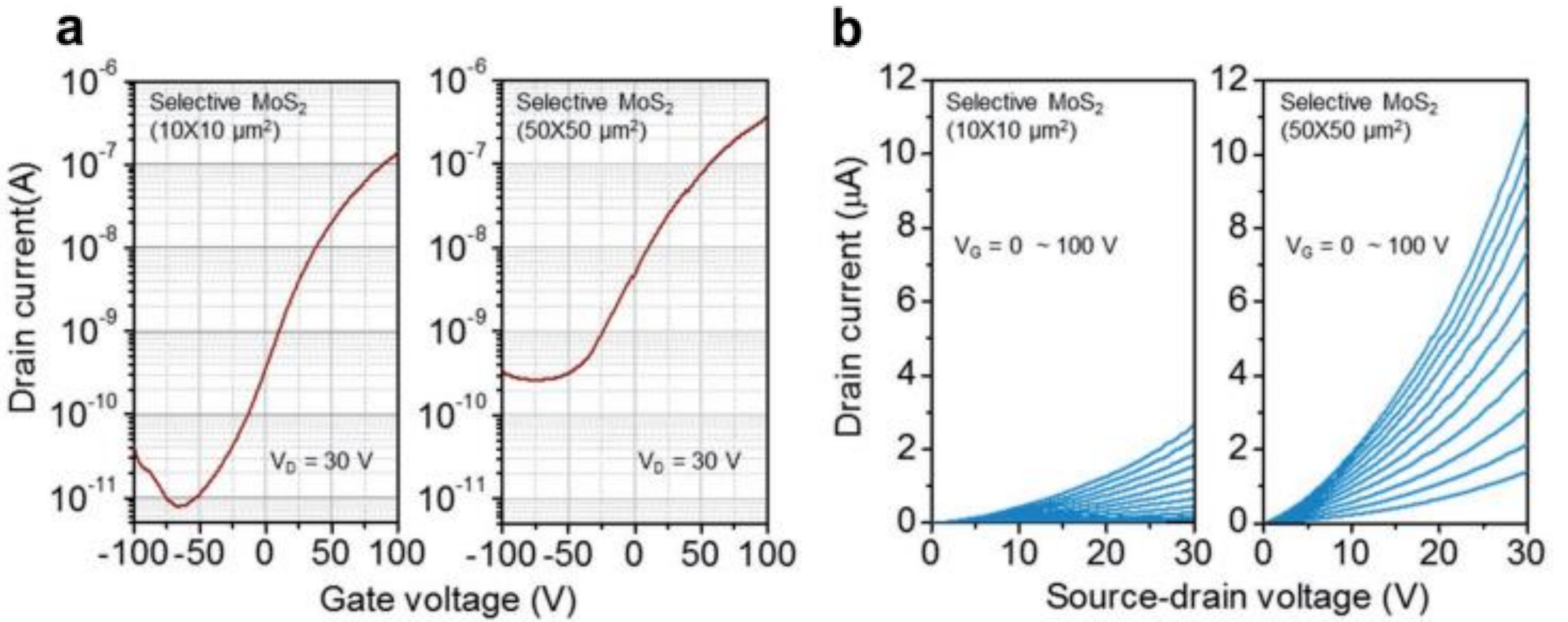
Using 1 mg of MoO_3 powder



Small **2017**, 1702256

Literature 1

Electrical properties with increasing size of the MoS_2 growth pattern.



Mobility increased by about 2.5 times from 0.044 to 0.116 $cm^2\ V^{-1}\ s^{-1}$ after increasing the MoS_2 grown size.

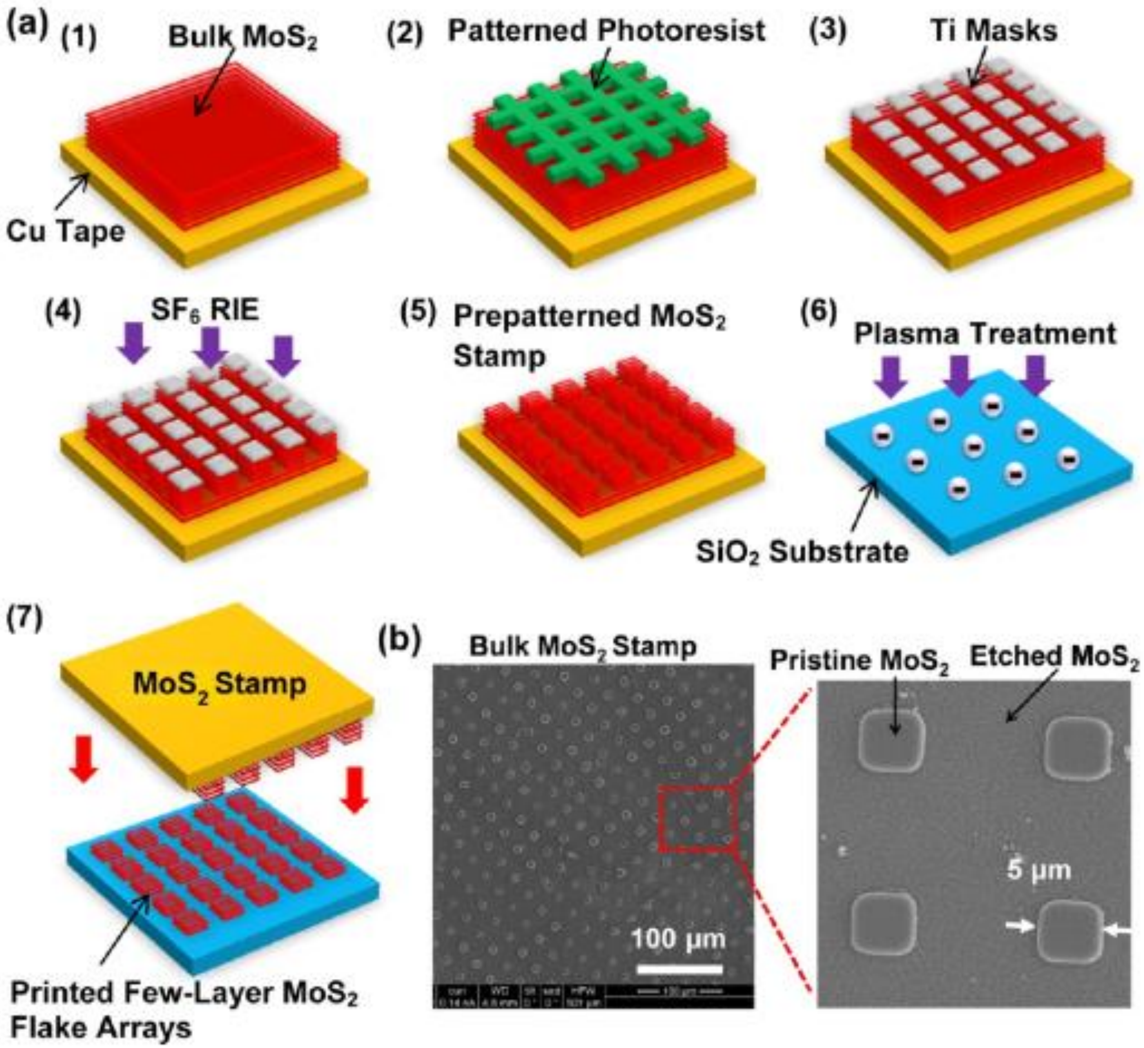
Grown size of MoS_2 increases, the grain size increases and the mobility increases.

Carrier scattering occurs in grain boundary and grain boundary decreases as grain size increases, so carrier scattering decreases, leading to an increase in mobility.

Small **2017**, 1702256

Literature 2

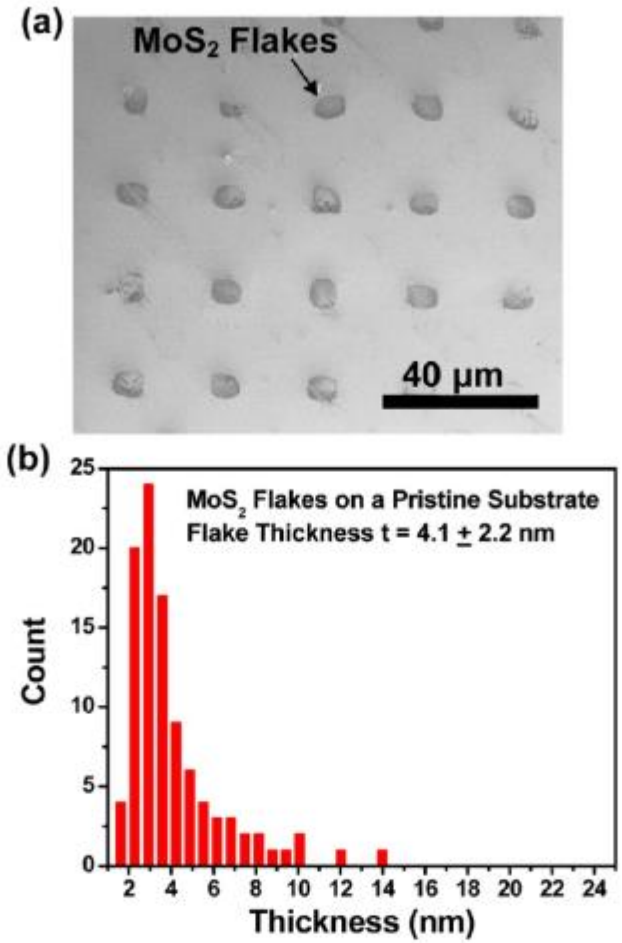
Transfer printing of prepatterned few-layer MoS_2 flakes

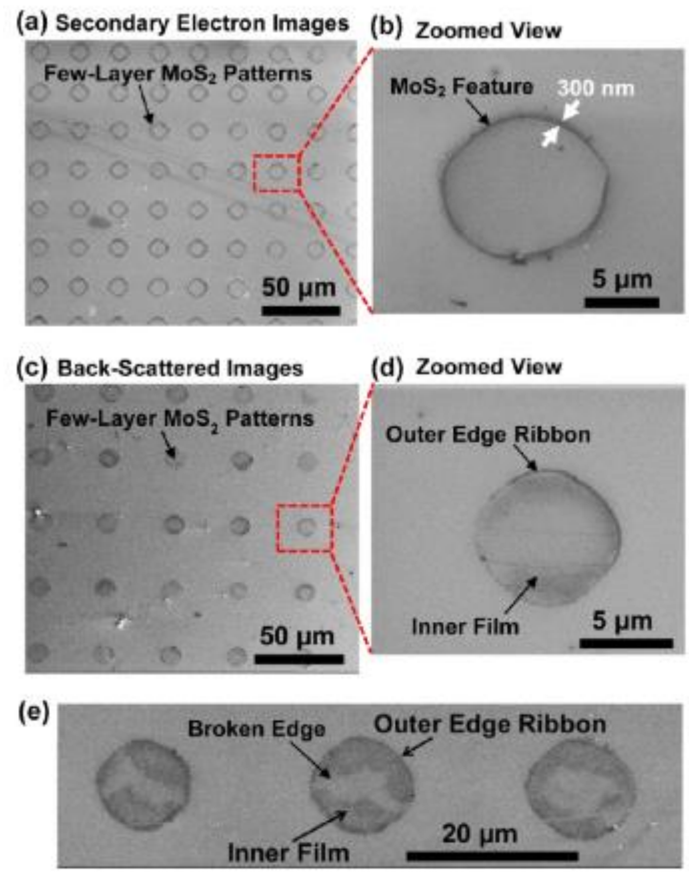


MoS_2 stamp

ACS nano, **2013**, 7(7): 5870-5881.

Literature 2



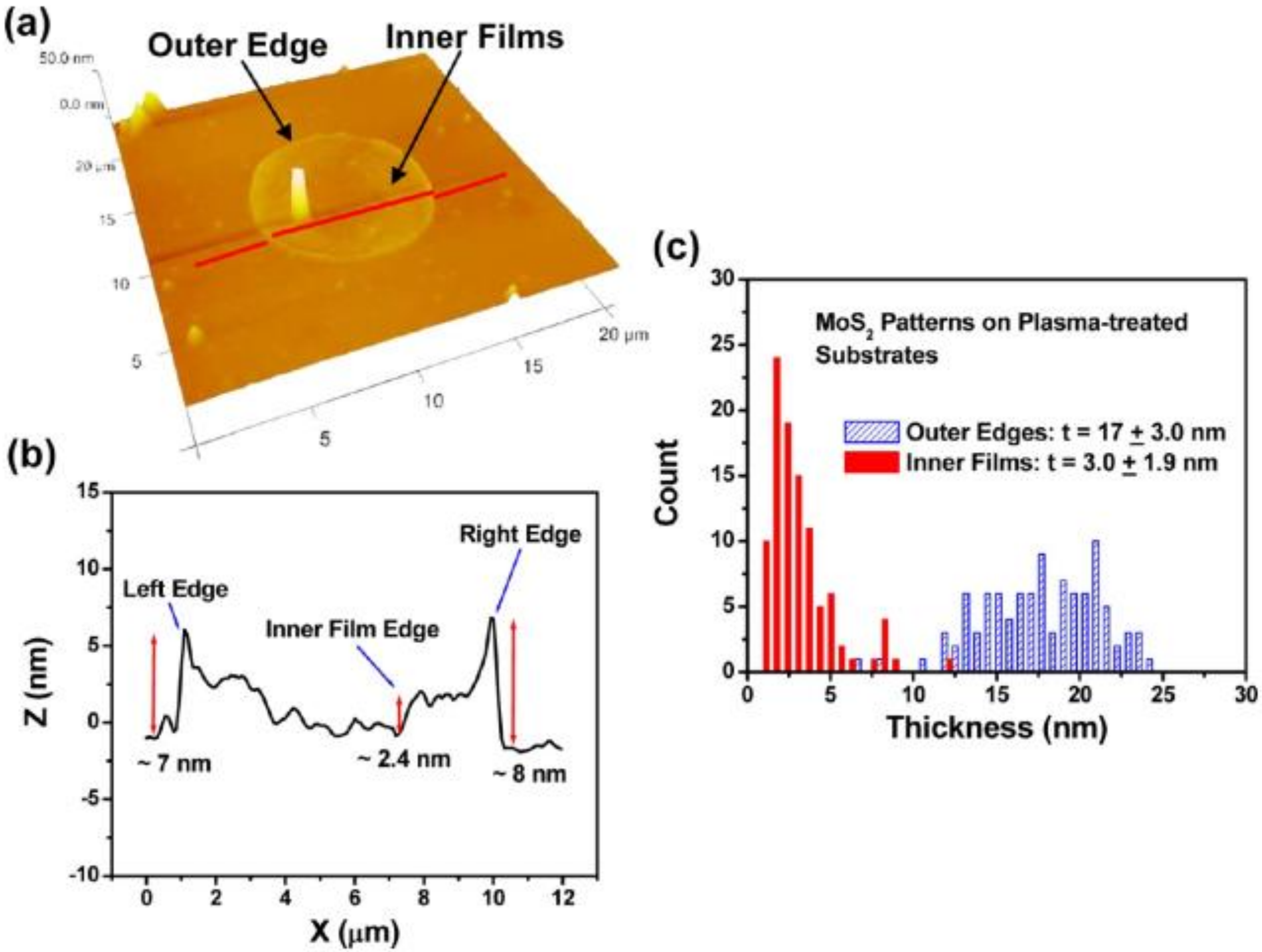


Arrays of 10 μm size MoS_2 flake pixels

Thin inner MoS_2 flakes
Broken inner films

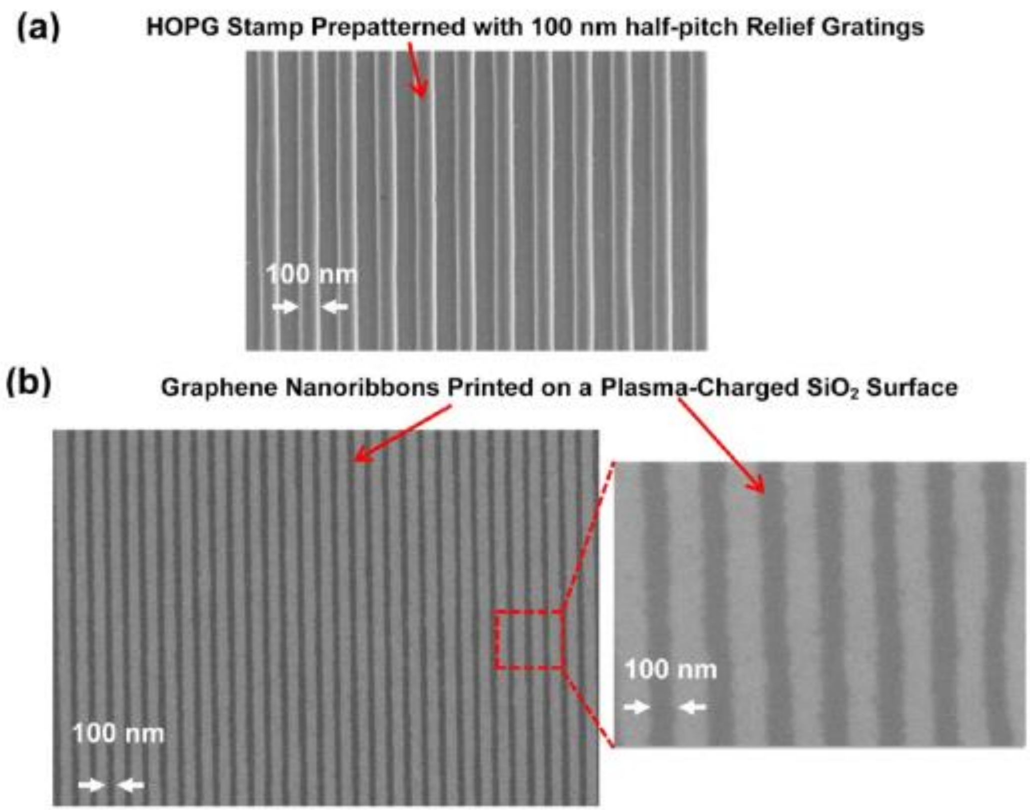
ACS nano, **2013**, 7(7): 5870-5881.

Literature 2



ACS nano, **2013**, 7(7): 5870-5881.

Literature 2



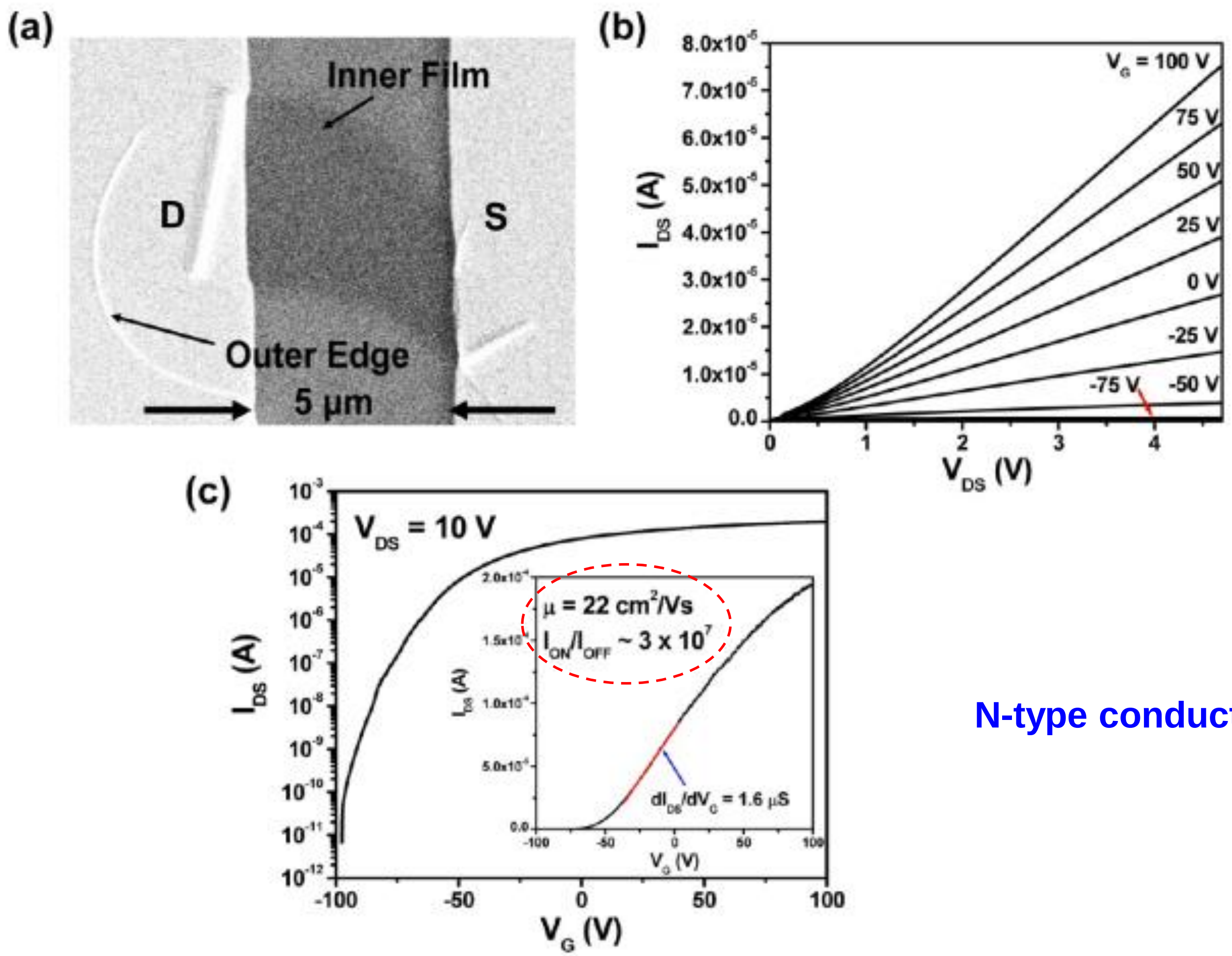
HOPG stamp prepatterned by using nanoimprint lithography followed with plasma etching.

Graphene nanoribbons printed onto a plasma-charged SiO_2 substrate.

ACS nano, **2013**, 7(7): 5870-5881.

Literature 2

FET made from the inner flake of a printed MoS_2 pixel



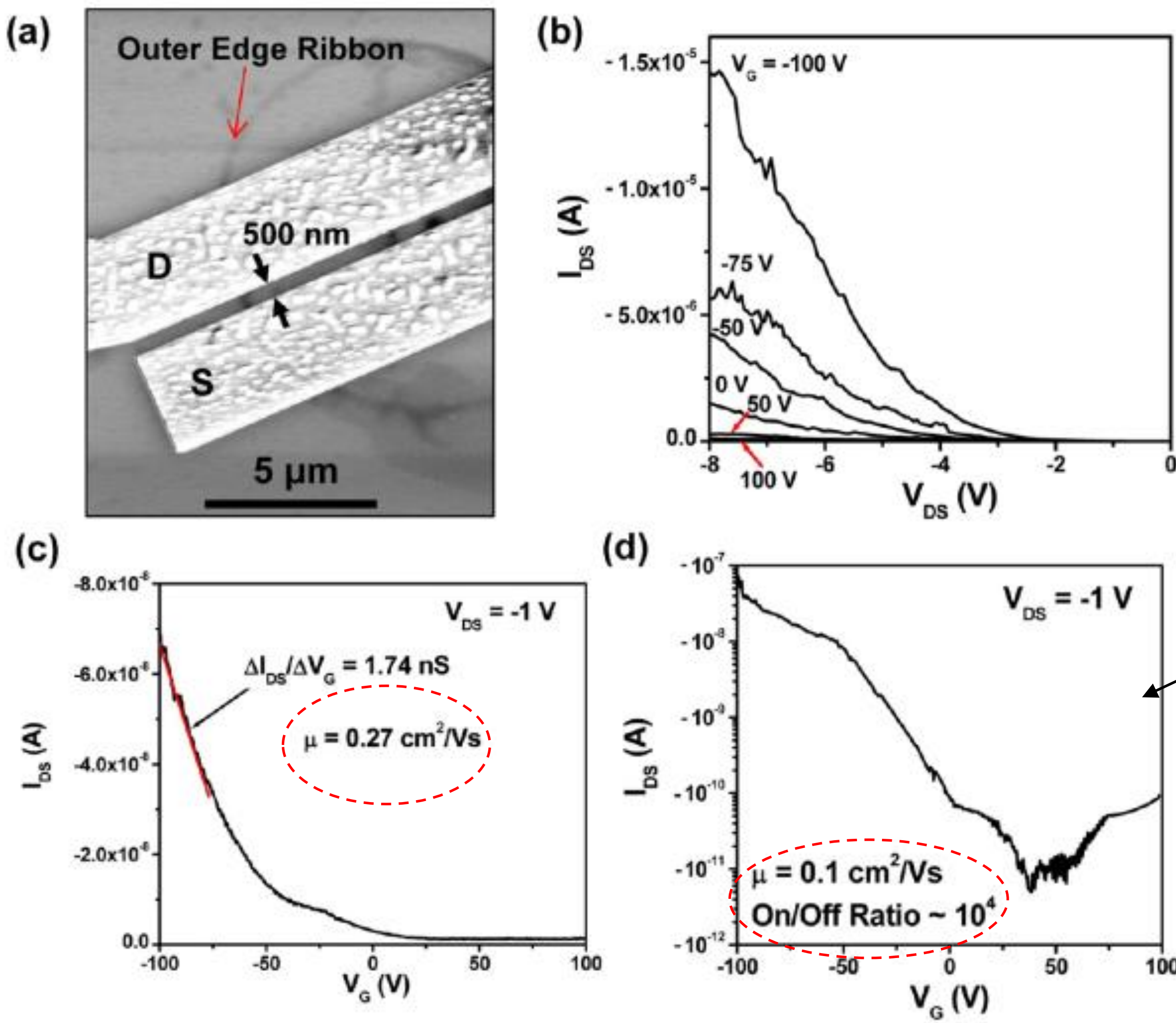
Thickness of ~5 nm
Width of ~3.7 μm
Length of ~5.4 μm

N-type conduction

ACS nano, **2013**, 7(7): 5870-5881.

Literature 2

FET made from the outer edge ribbon of a printed MoS_2 pixel



Width of ~300 nm
Length of ~500 nm

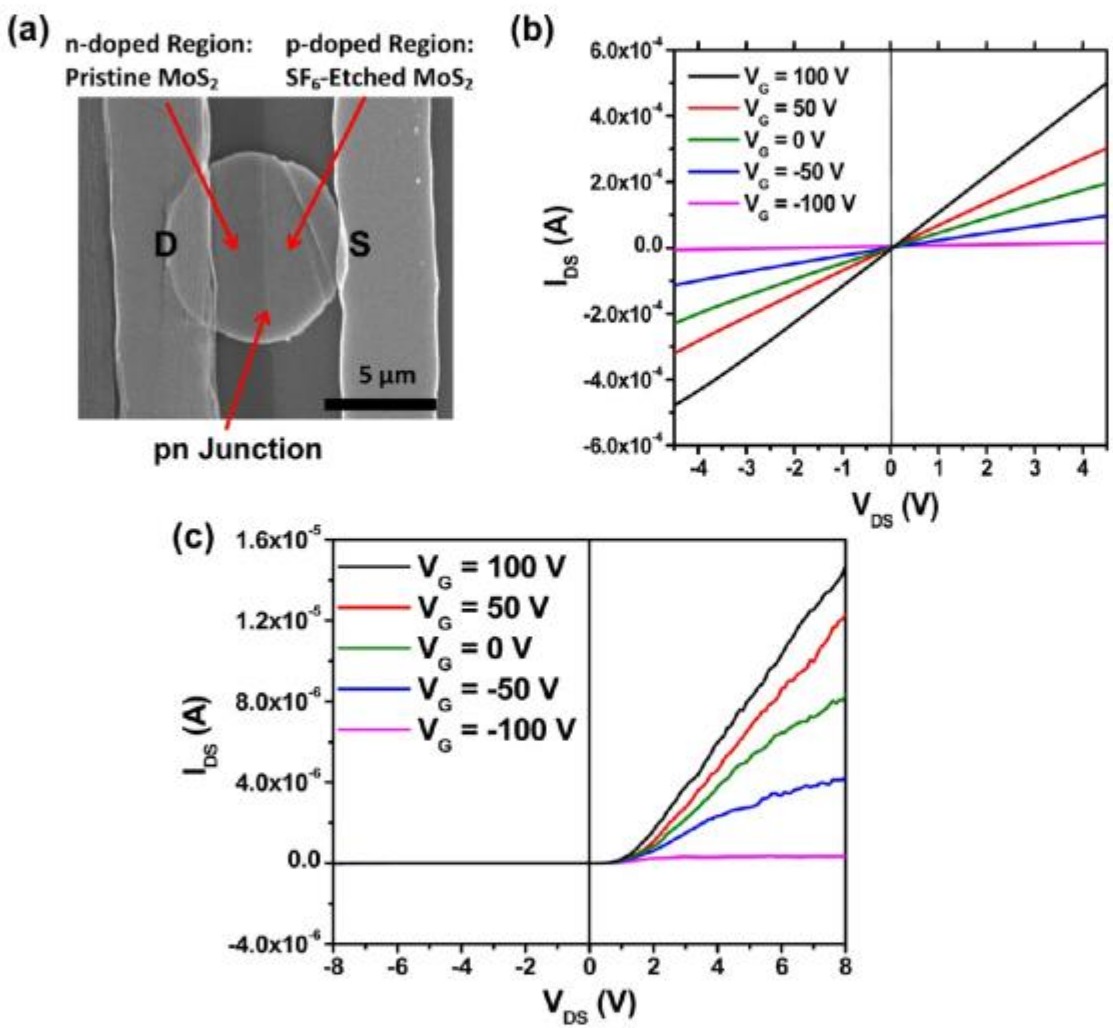
Treated by SF_6 plasma

P-type conduction

ACS nano, **2013**, 7(7): 5870-5881.

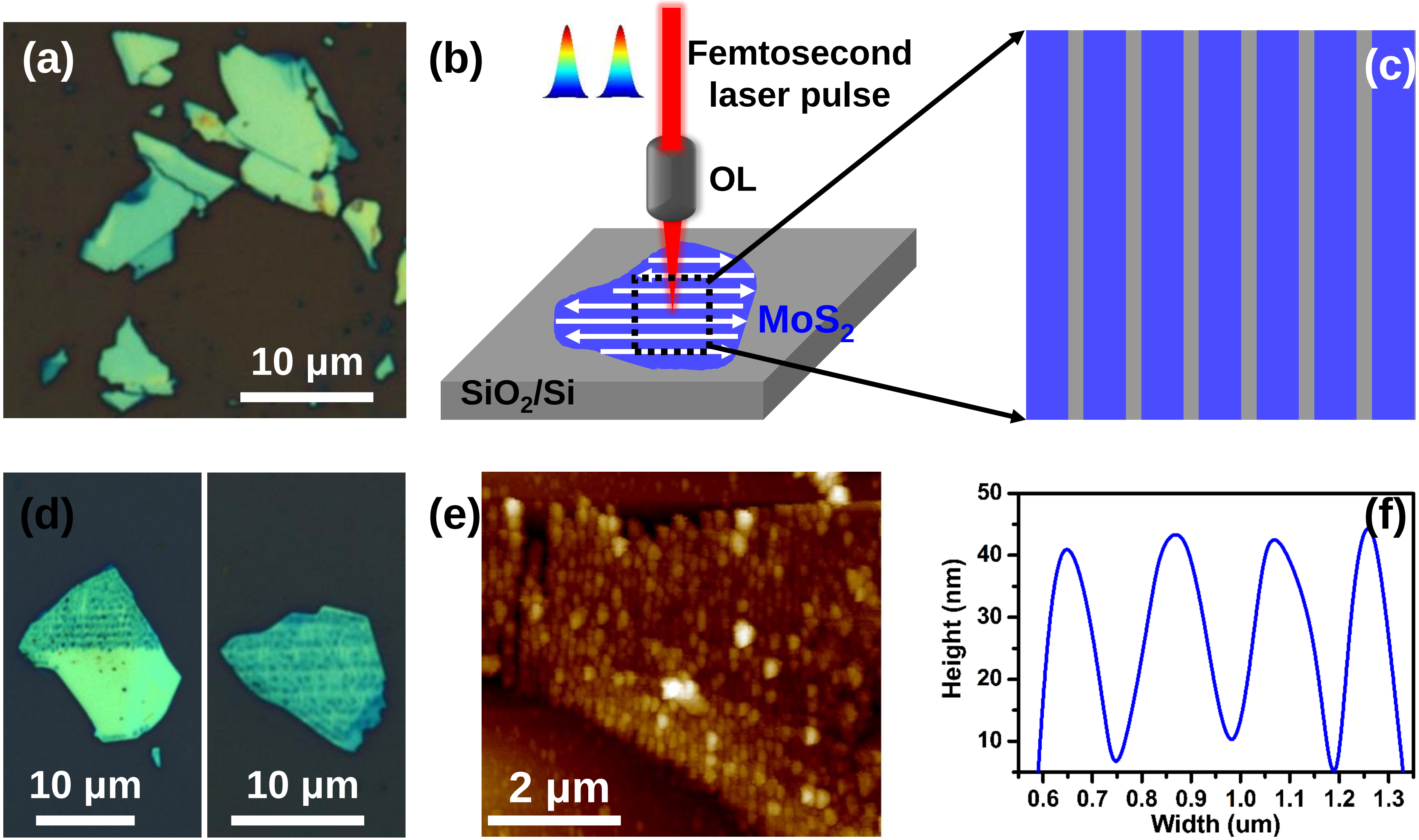
Literature 2

PN junction formed by the partial etching of a MoS_2 pixel



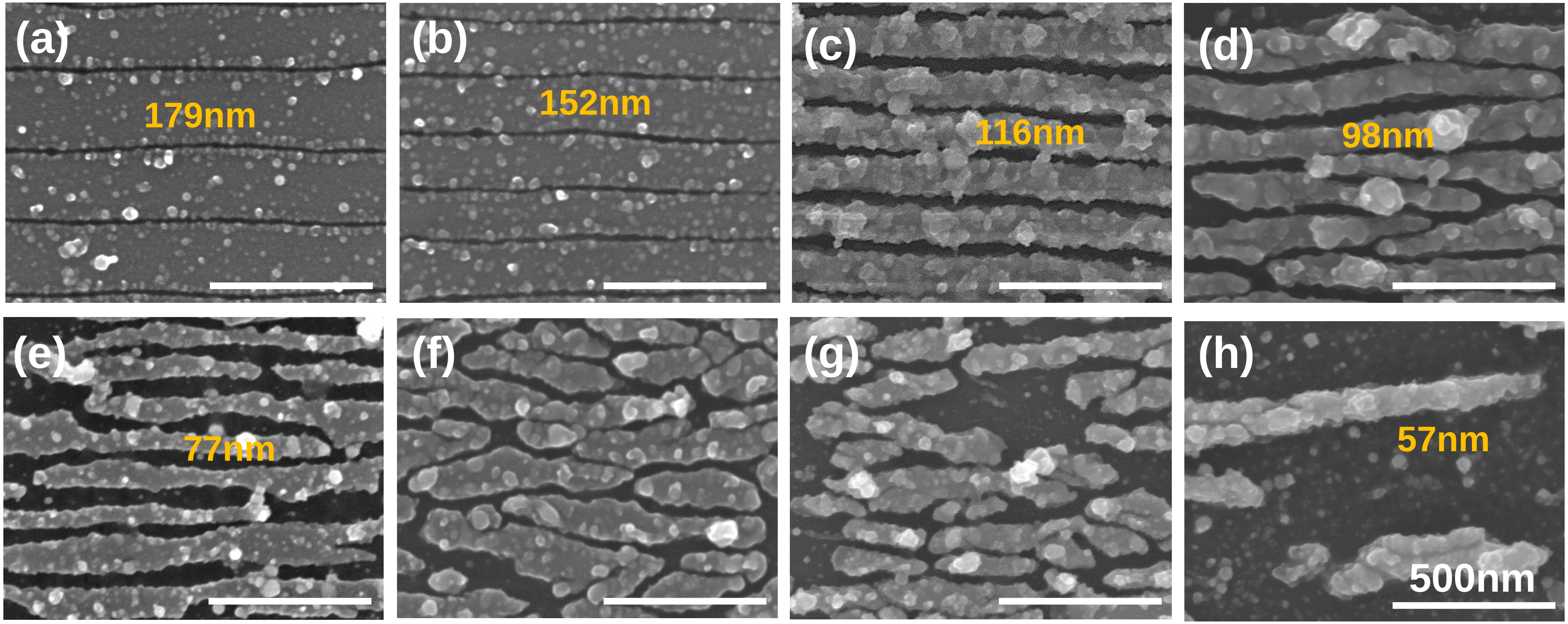
ACS nano, **2013**, 7(7): 5870-5881.

Experiment



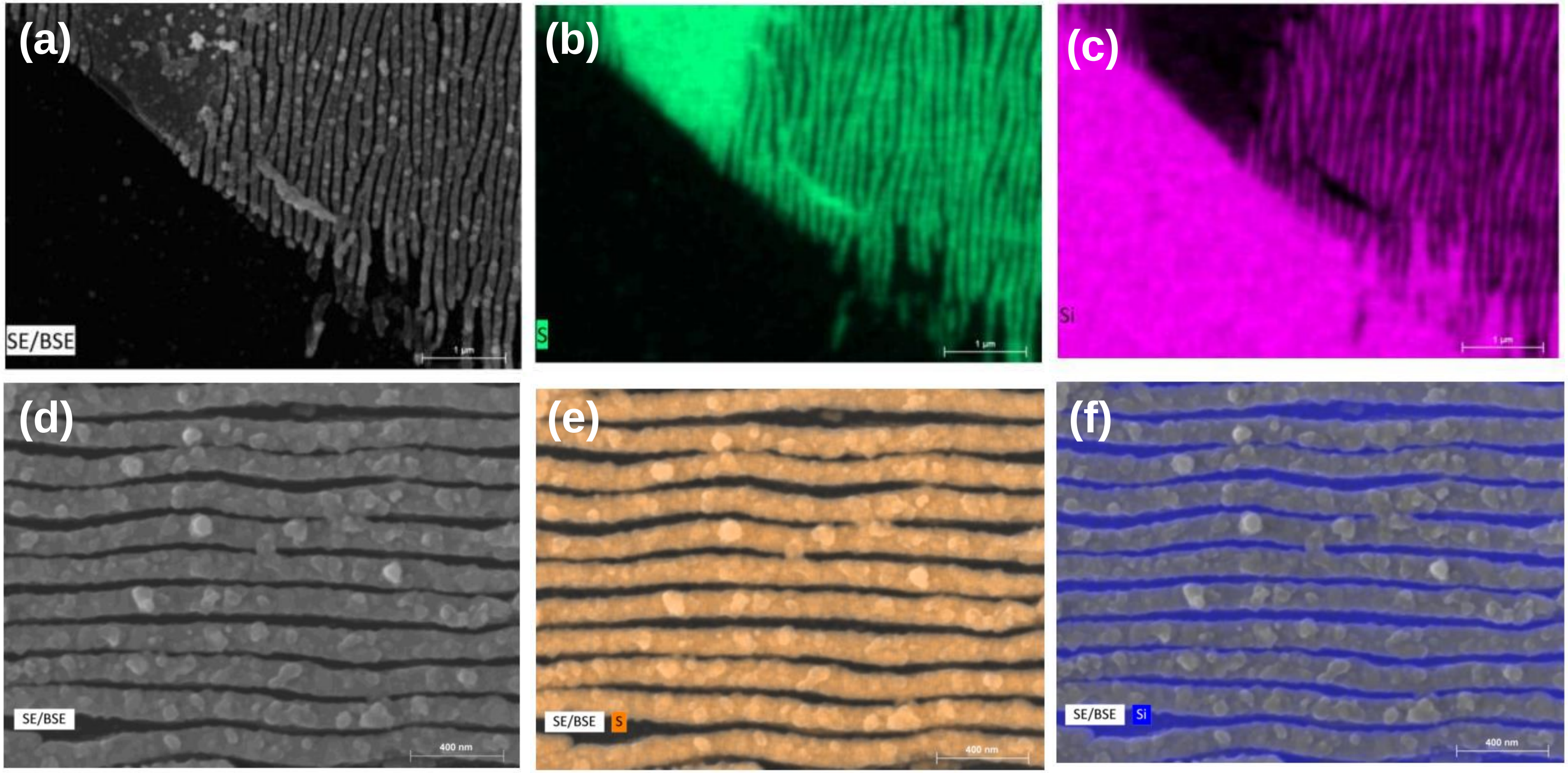
Thining and nanoribbons

Experiment



Nanoribbons with different width

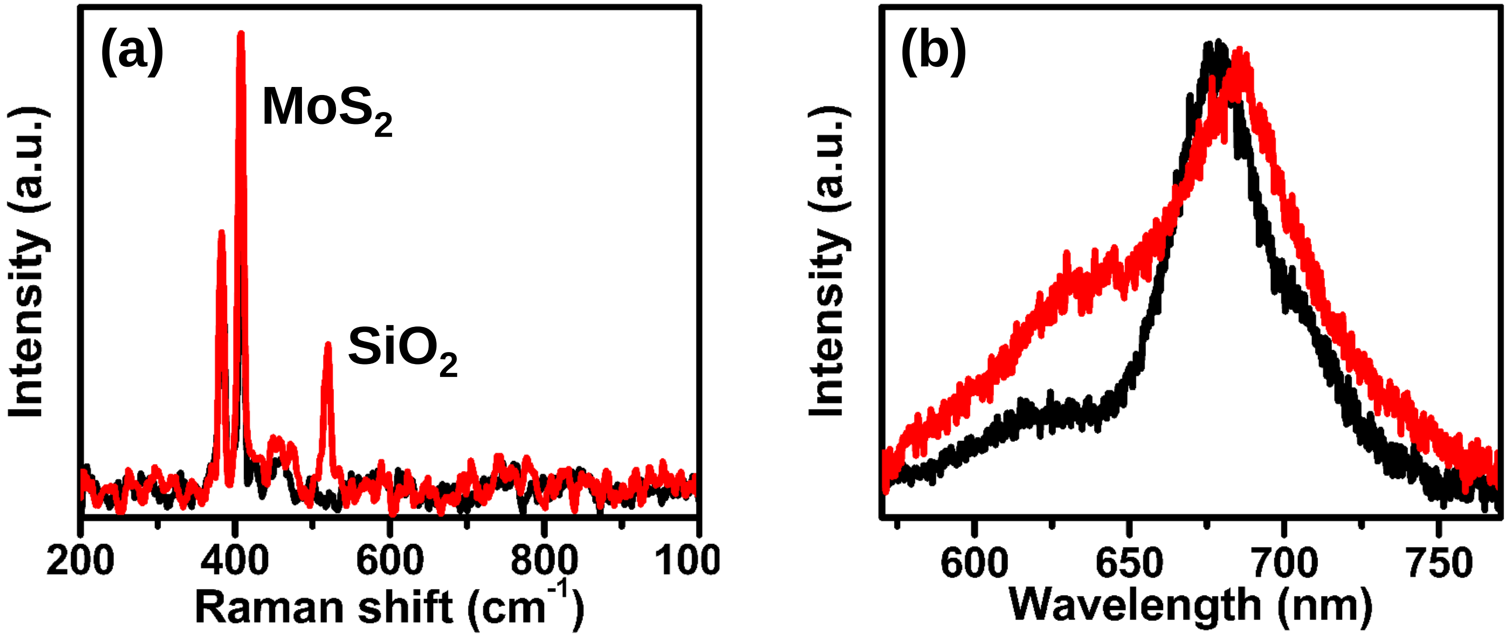
Experiment



EDX mapping of nanoribbons

Proved penetration of nanogap

Experiment



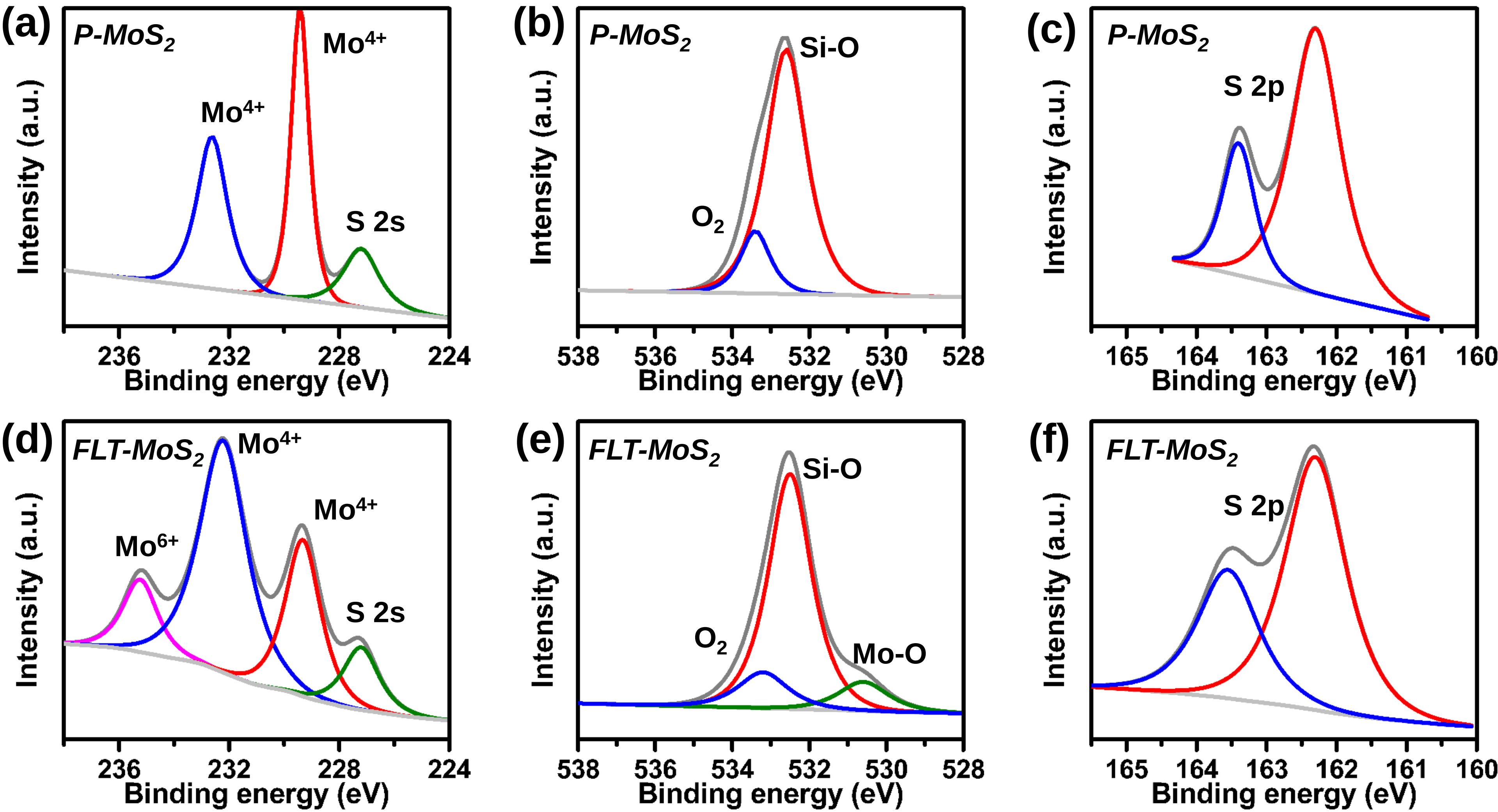
No thermal oxidation
Substracte was detected

No obviously high peak
Proved no monolayer

Proved penetration of nanogap

Raman and PL spectra of nanoribbons

Experiment



O_2 absorption **P-doping**

FET relative calculation

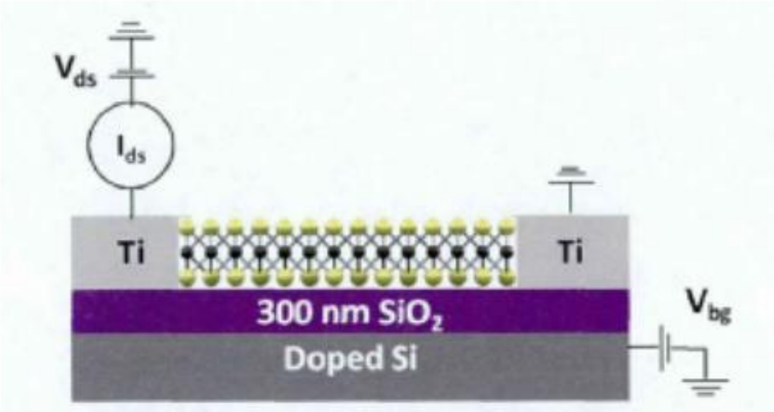
On/Off=$I_{on}/I_{off}=I_{max}/I_{min}$ (according to transfer curve)

Mobility ($cm^2V^{-1}s^{-1}$)

$$\mu = \frac{L}{W}\frac{d}{\varepsilon_0\varepsilon_r}\frac{1}{V_{sd}}\frac{\partial I_{sd}}{\partial V_g}$$

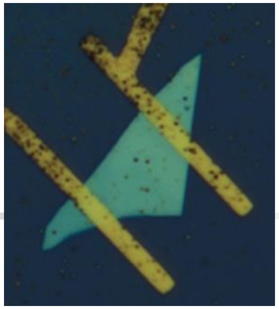
SS (mV/dec)

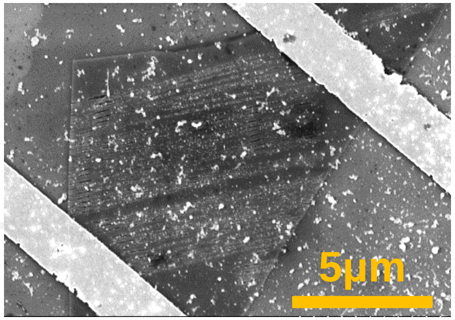
$$SS = \frac{\Delta V_g}{\Delta log I_d}$$

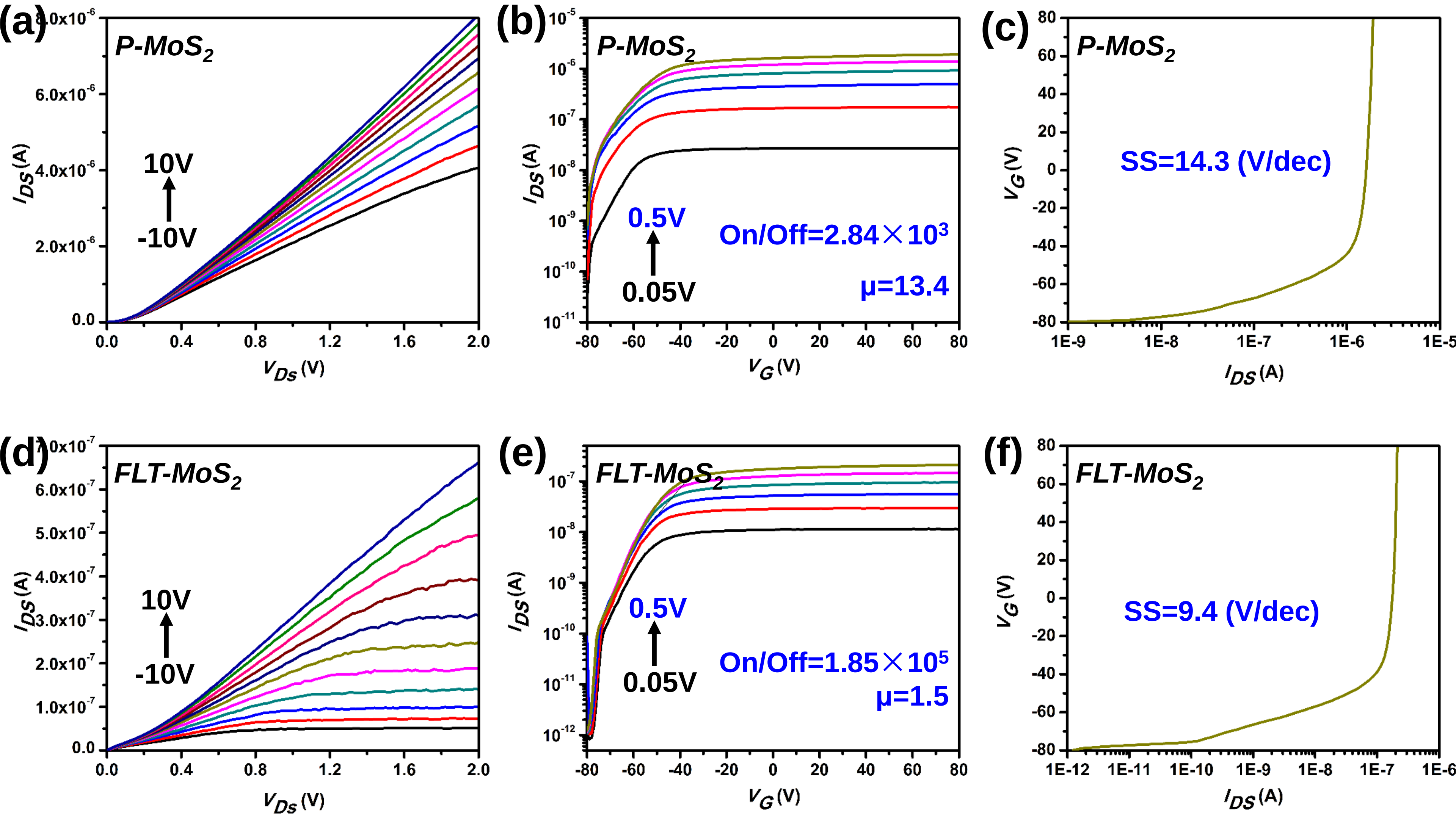


Experiment

FET rectifying by laser modification







Experiment

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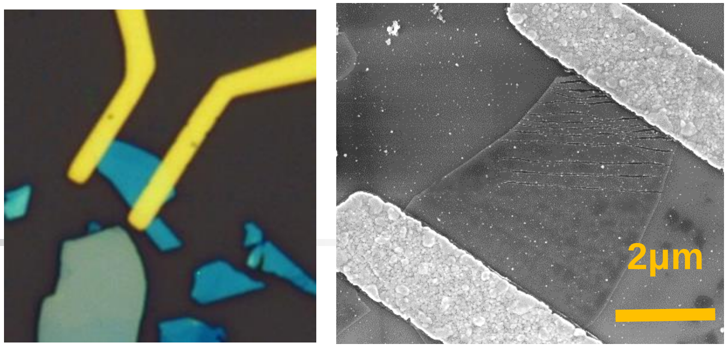
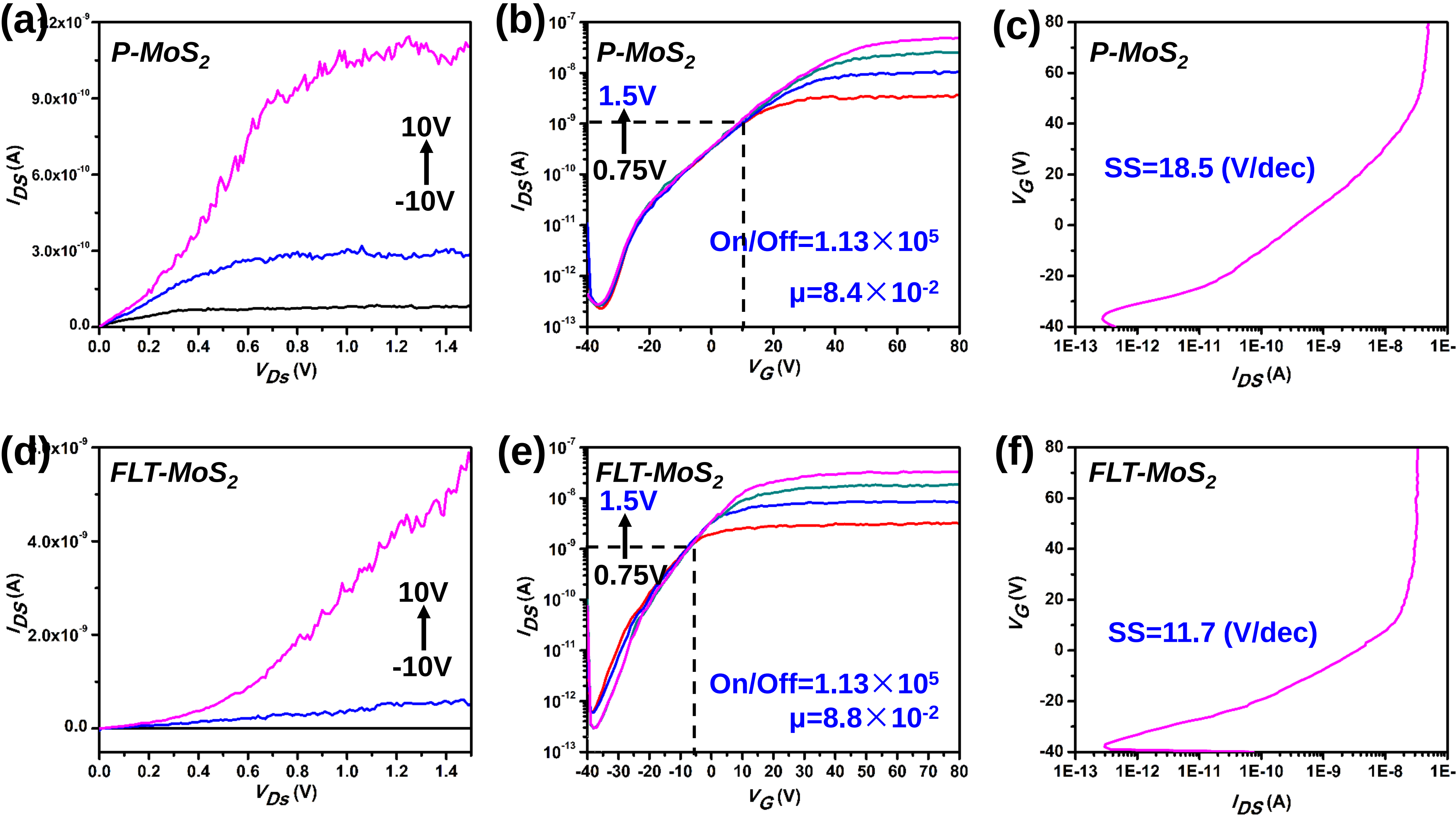
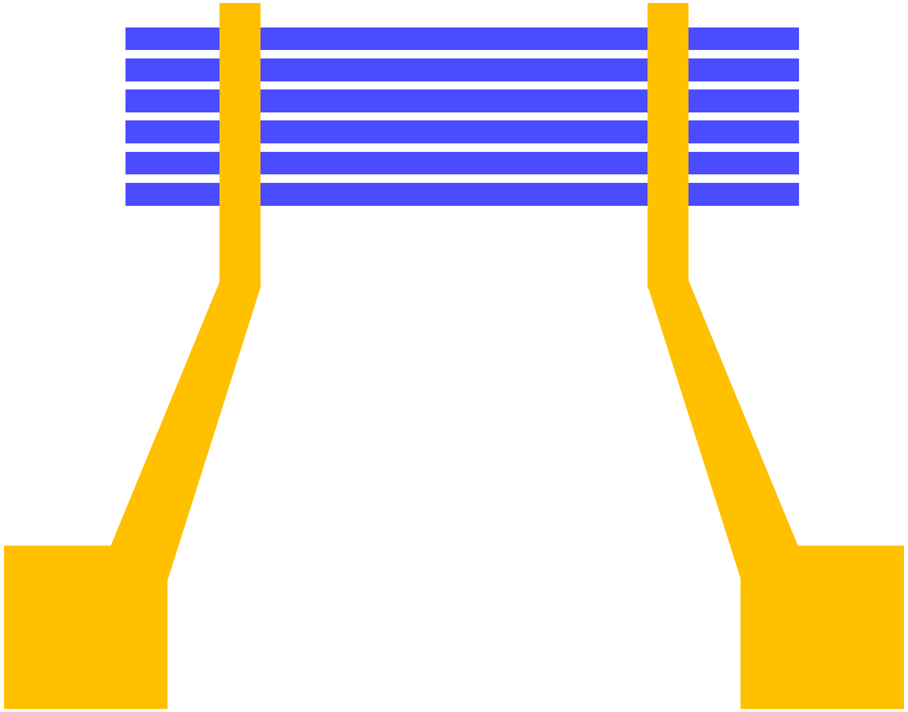




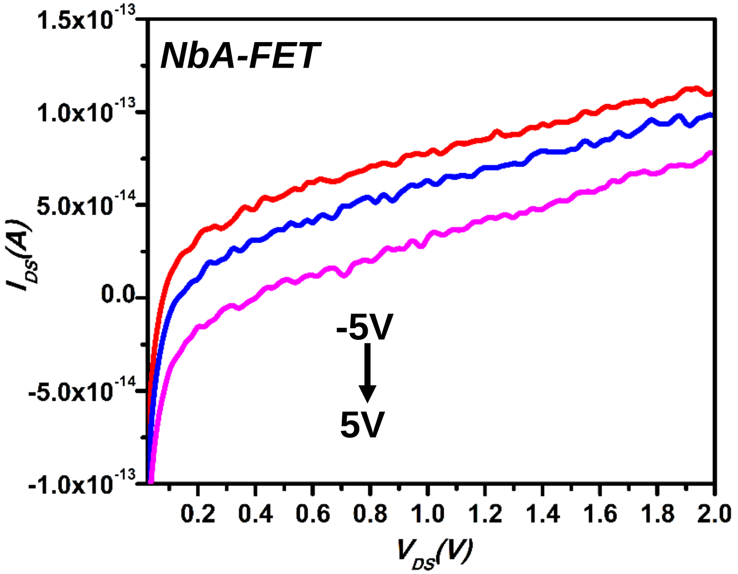
Experiment

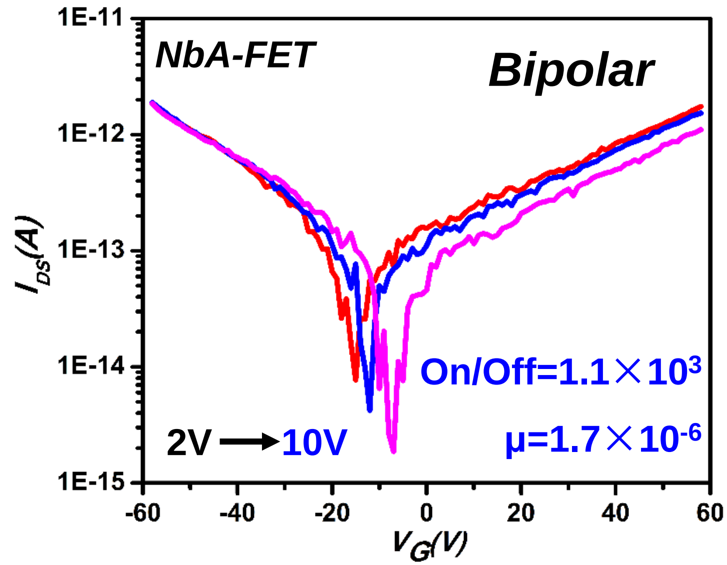


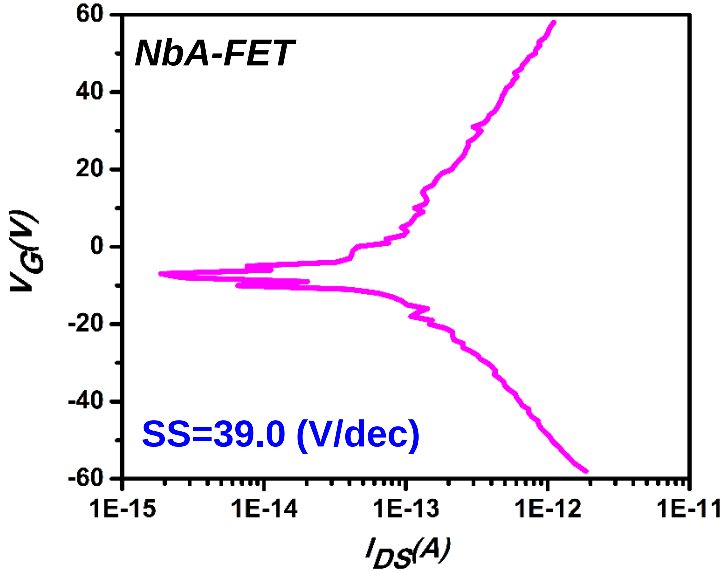
Nanoribbon arrays for FET

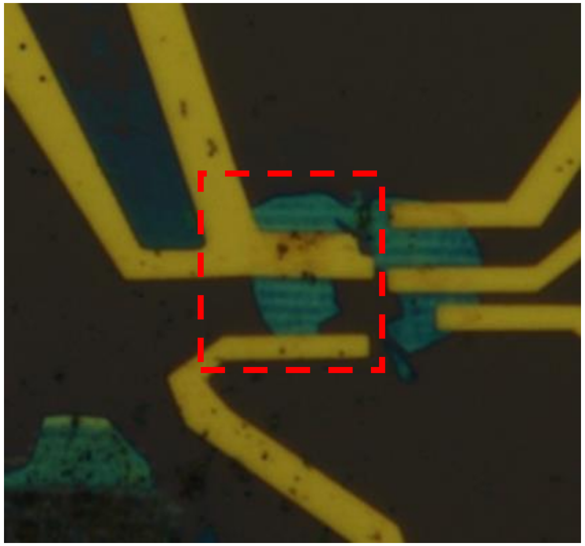
Experiment

Nanoribbon arrays for FET







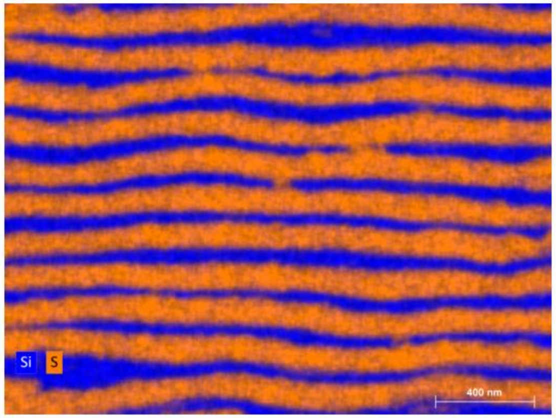


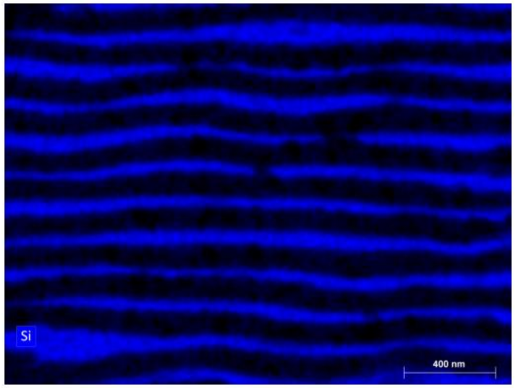
重做

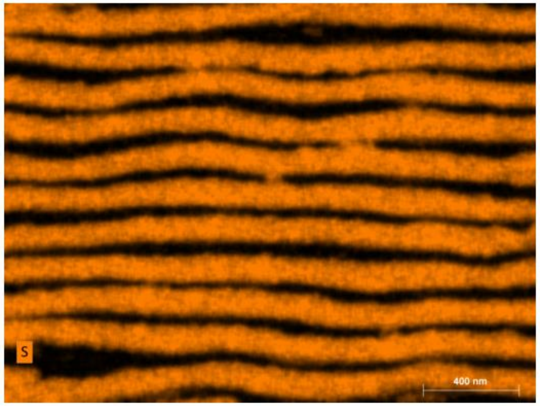
Future plans

- Optimizing experimental results
- Reading literatures to analyze experimental results

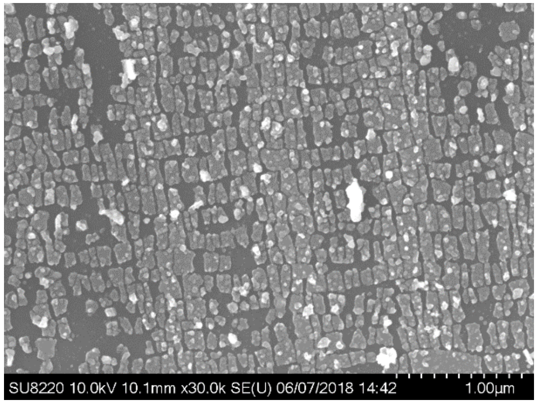
Thanks for Attention!

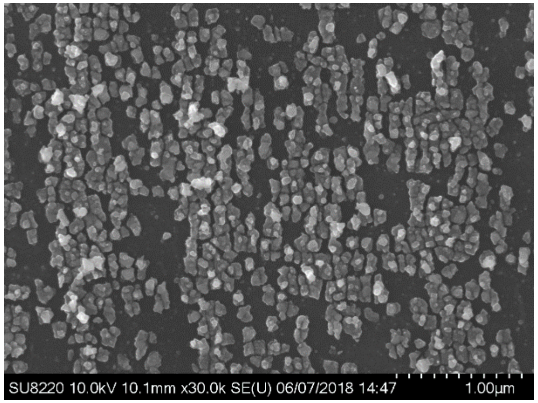

Si
S
400 nm

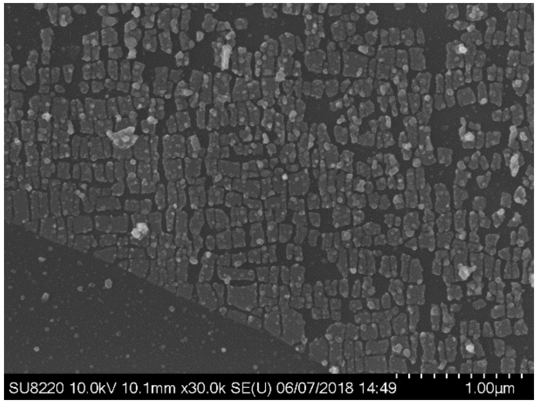

Si
400 nm


S
400 nm

SI


SU8220 10.0kV 10.1mm x30.0k SE(U) 06/07/2018 14:42
1.00µm


SU8220 10.0kV 10.1mm x30.0k SE(U) 06/07/2018 14:47
1.00µm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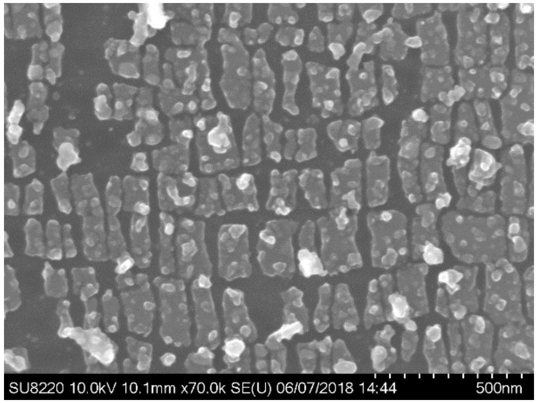
1.00µm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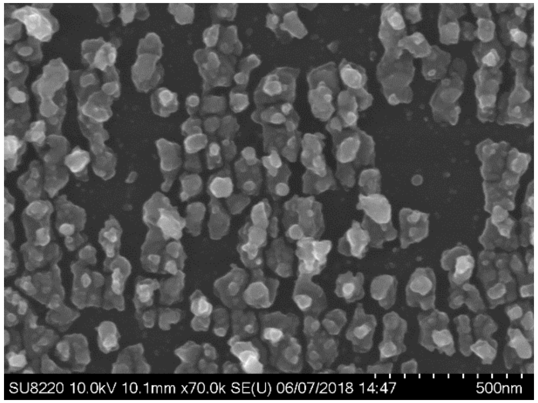
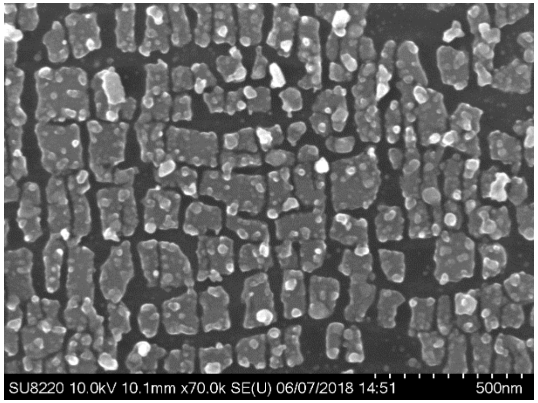
500nm


SU8220 10.0kV 10.1mm x70.0k SE(U) 06/07/2018 14:47
500nm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500nm