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Technique for Advanced Materials

Multifunctional Thermal Stage

Micro-STS 1200

Aug. 2024

Units Technology Co., Ltd.

UNITS Tech is a high-tech science facilities manufacturer. According to the new two-dimensional materials research demand during the sub-nano time, we have invented visualizing CVD devices for observing and recording the growth process of two-dimensional materials.

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Micro-STS 1200

Introduction

Micro-STS 1200 – What is it

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visualizing CVD devices

Traditional Tube furnaces

Traditional thermal stage

Micro-STS 1200 is a multifunctional Thermal Stage combined with traditional tube furnaces and traditional thermal stage, realizing the combination with In-situ synthesis and In-situ optical characterization.

Micro-STS 1200 – Technological advantages

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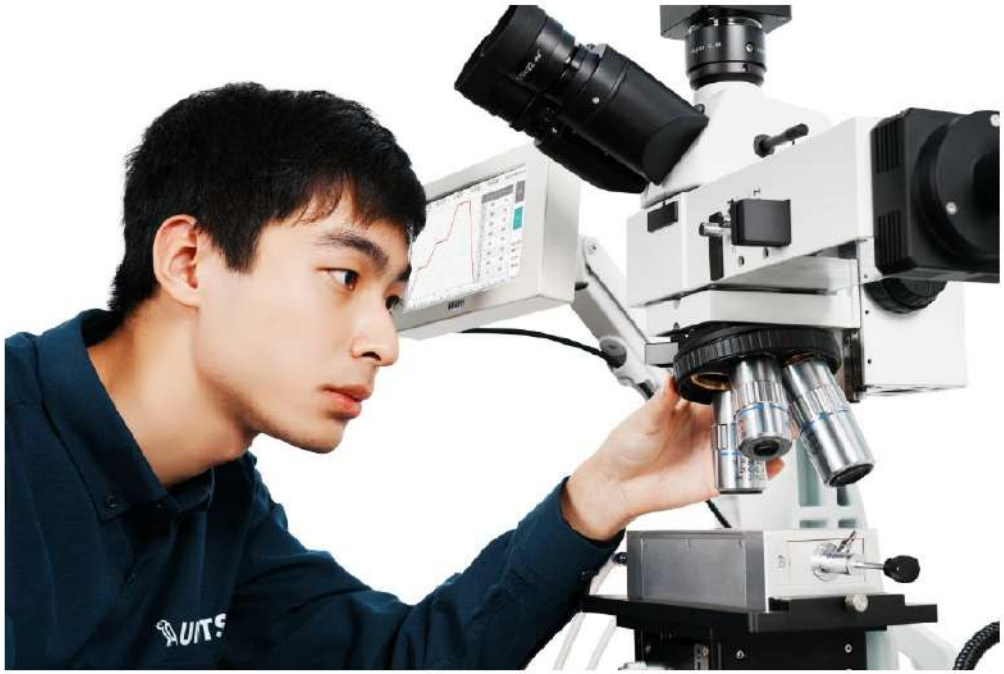

Visualization system

- Compatible with microscopy and spectroscopy
- Highest magnification of 500x. Resolution≈1.5 μm

High efficiency High precision

- Fast temperature raising/falling rate up to 100°C/min
- Precisely 0.5°C control from RT to maximum limiting temperature 1100°C

Suitable for different gases

- Nitrogen, Argon, Oxygen, gas mixtures etc.
- Available for LPCVD

Customized sample location

- Precise control of the sample location
- Easy to accomplish annealing and hardening of the materials

Compact size Large heating field

- Light weight, flexible methodology and inexpensive price
- Volume: 175*80*50mm
  Heating Zone: 40*10*10mm

Safe and low energy consumption

- Surface temperature lower than 40°C
- Power consumption lower than 0.4kW

Micro-STS 1200 Advantages

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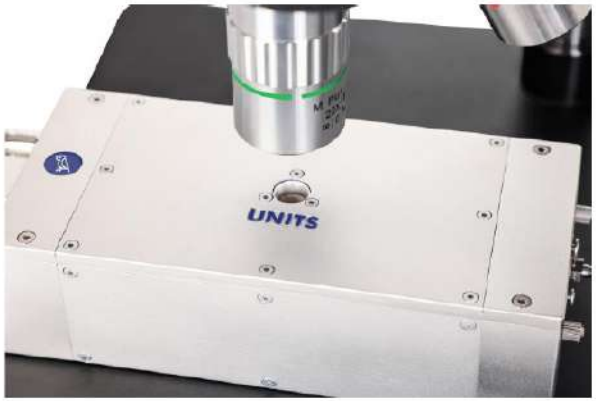
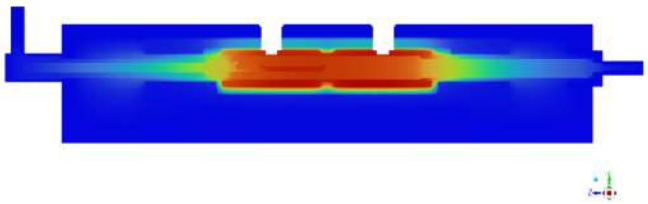
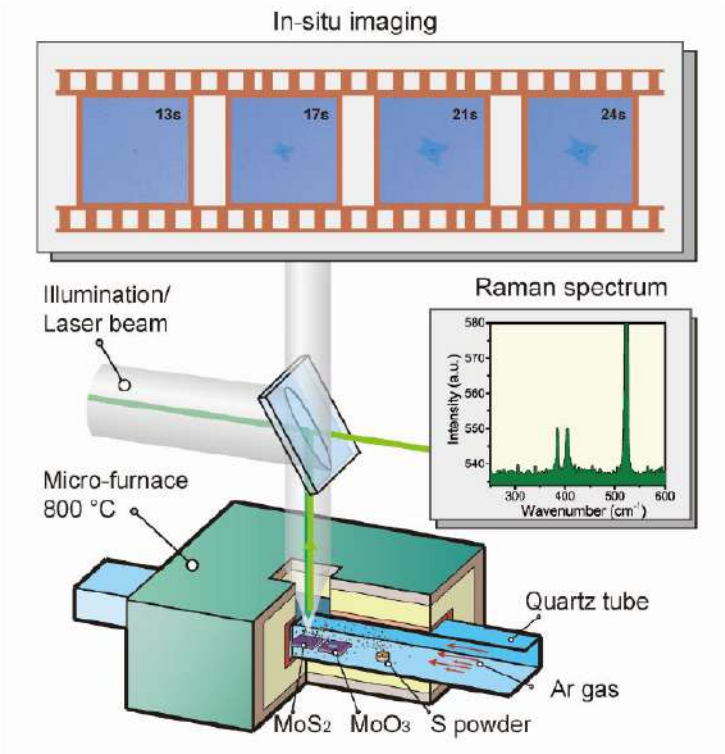
1. Visualization system





- Compatible with microscopy
- Highest objective lens magnification of 50X
- Uniform heating field distribution
- Low surface temperature
- High Numerical Apertures
- Wide transmittance spectrum



Compatible with spectroscopy

Micro-STS 1200 Advantages

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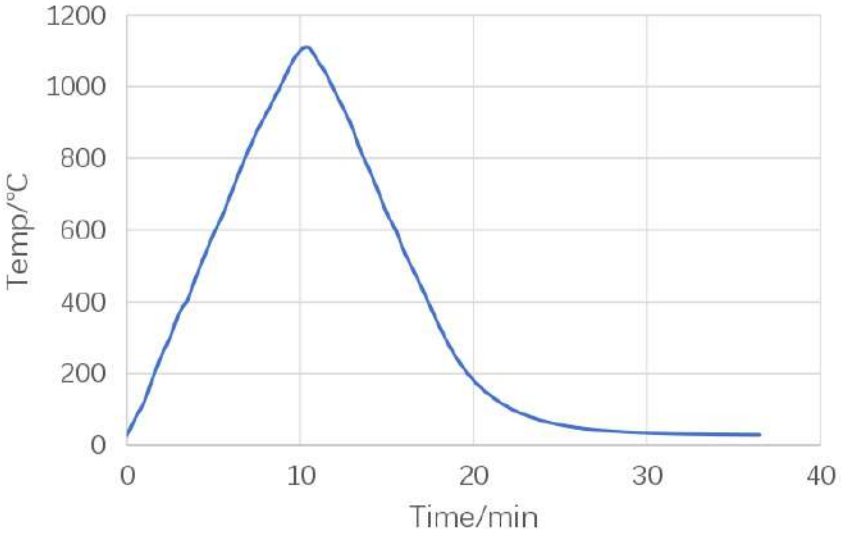
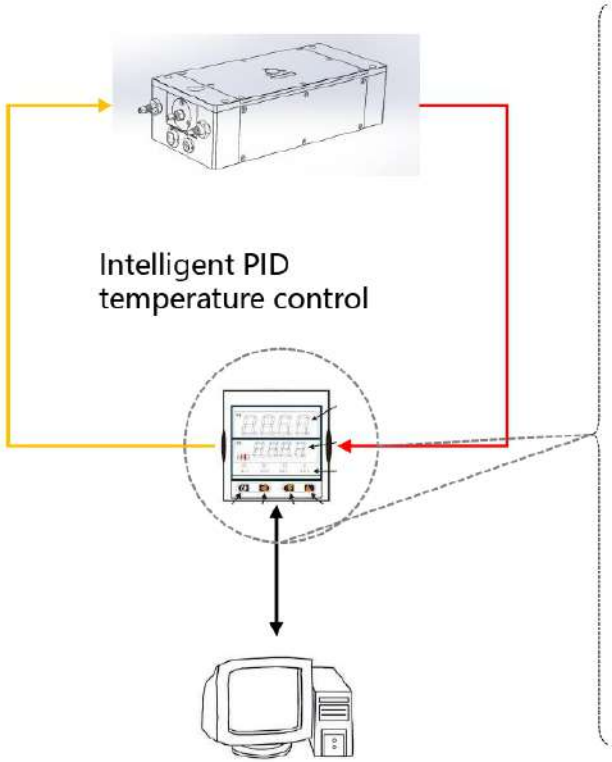
2. High efficiency, high precision





Yu Dian Tech

Omron

Eurotherm

Temperature raising/falling rate ≤100℃/min
(It is recommended to control the heating rate at temperatures above 600℃ to within 60℃/min.)
Temperature Control Accuracy =±0.5℃
Temperature Measurement Accuracy=±0.1℃

Micro-STS 1200 Advantages

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3. Suitable for different gases

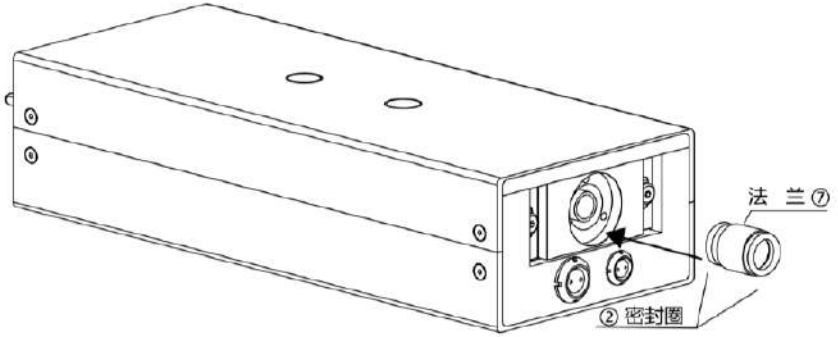
Inter gases

Oxidizing atmosphere

Gas mixtures

LPCVD

- **Quartz material**
- **Good corrosion resistance**



- **Self-developed water-gas transition system**
- **Suitable for 2 gas channels**

- **Multiple seal structure**
- **LPCVD**

Micro-STS 1200 Advantages

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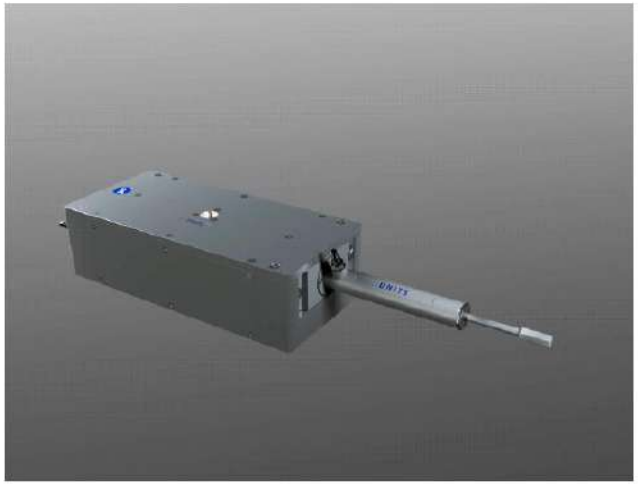
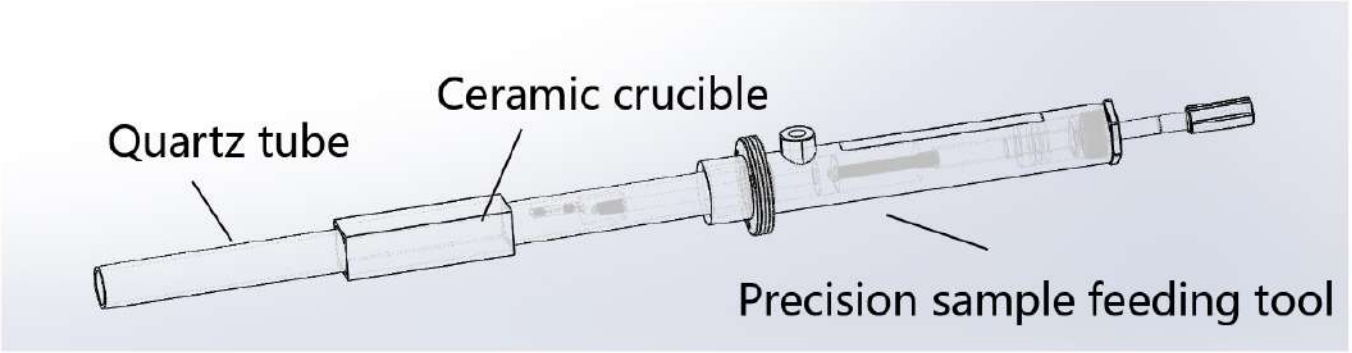
4. Customized sample location



Source feeding



- **Precisely control the sample location by pushing in/pulling out**
- **Easy to realize annealing/quenching of the materials**
- **Moving stroke=80mm**

Micro-STS 1200 Advantages

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5. Compact size, large heating field

Single zone

Size: 175*80*50mm

Heating zone: 40*10*10mm

Dual zone

Size: 220*80*50mm

Heating zone: 80*10*10mm

Ceramic crucible

Size: 18×5×1.6mm

Micro-STS 1200 Advantages

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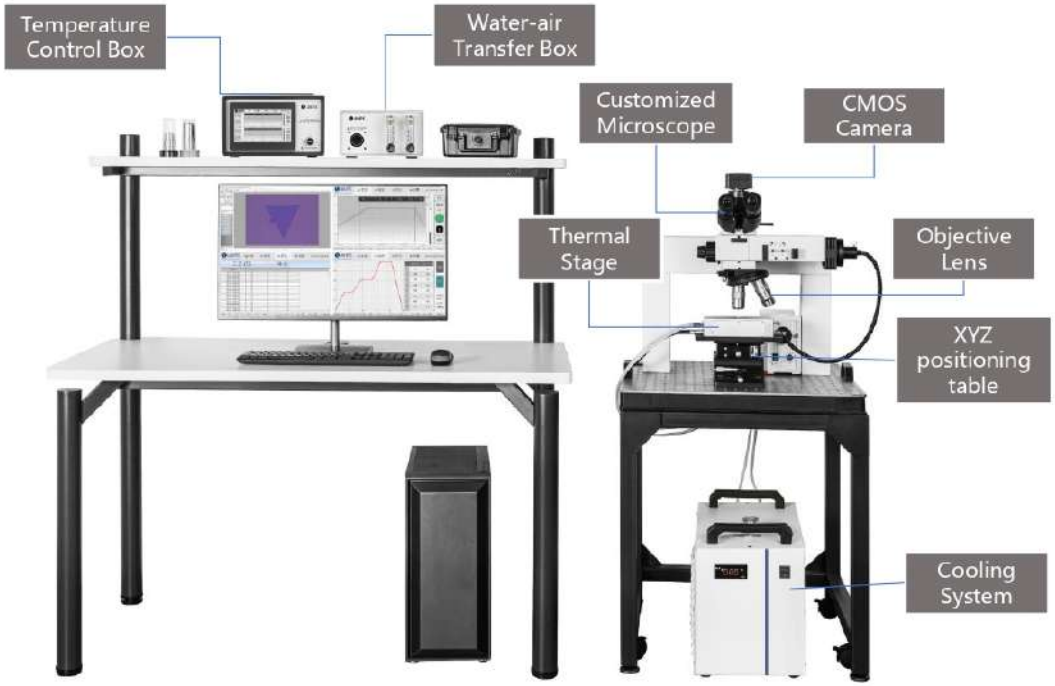
6. Safe and low energy consumption



- **Circulating Cooling Furnace Design**
  The water circulating cooling system ensures that the stage surface temperature close to the room level
- **Low energy consumption**
  The power of the whole system lower than 1.5kW
- **Inside warning system**
  The built-in alarm system ensures the experiment is safe and controllable

Project deliverables

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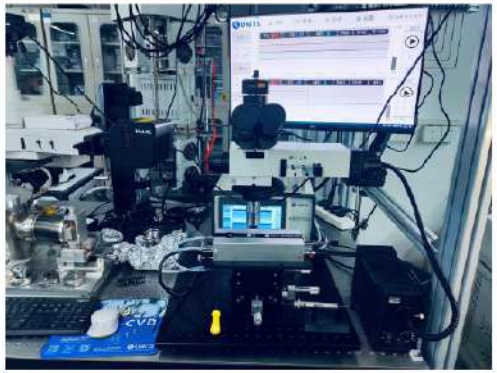
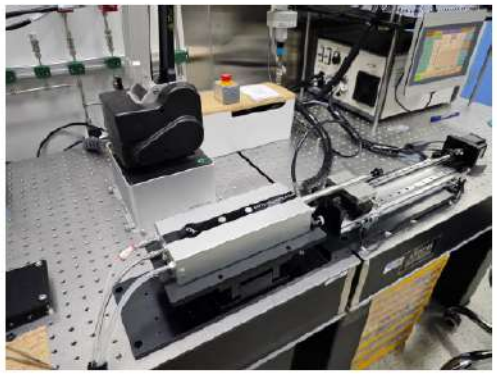
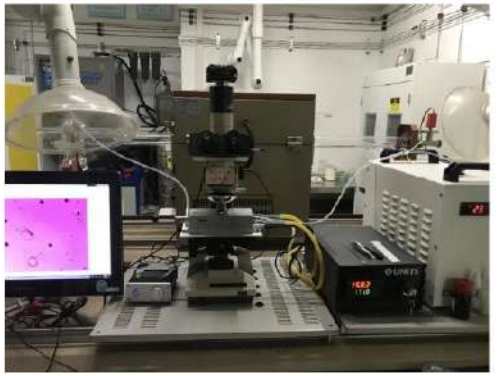


BGI-graphene
Academician Liu Zhongfan

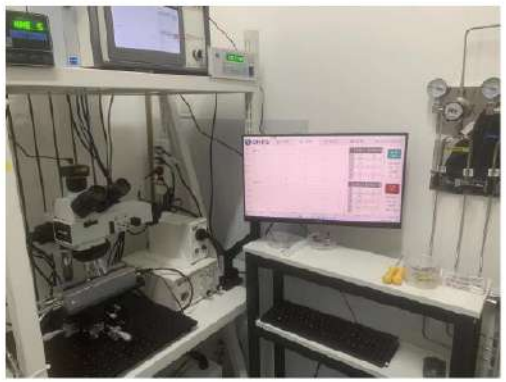


PKU-CNT
Academician Zhang Jin

USTB-TMDC
Academician Zhang Yue

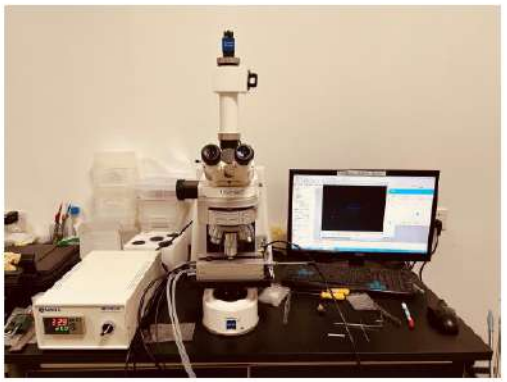


Fudan University-TNAs
Academician Liu Yunqi

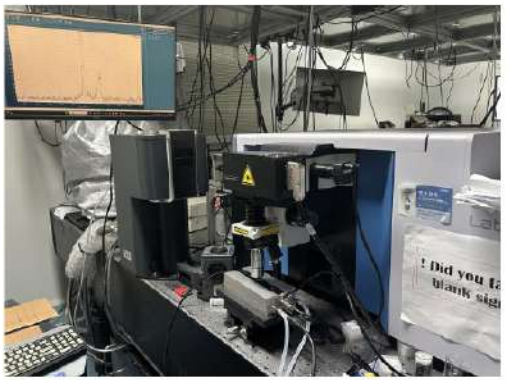


BIT—$MoTe_2$

Hunan University—WS_2



HUST--Disulfide



NJU-- CVD+ Raman

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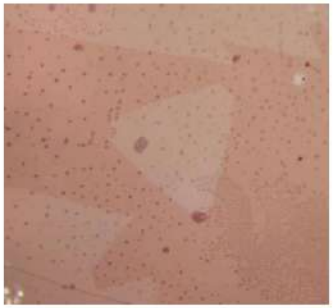
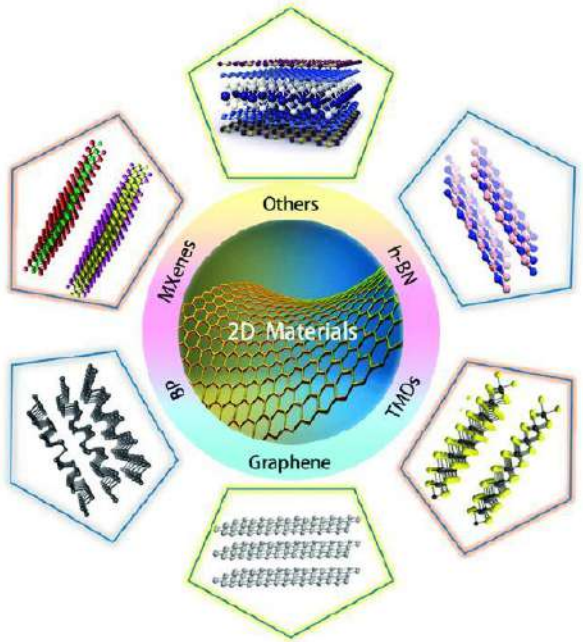
Applied materials

- √ Graphene
- √ MoS_2
- √ $MoTe_2$
- √ MoO_3
- √ CNT
- √ WS_2
- √ WO_3
- √ Bi_2O_2Se
- √ Rare earth material
- √ Copper
- √ More to explore





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Application

Application1 High-Temperature In Situ Investigation of CVD

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ACS APPLIED ELECTRONIC MATERIALS

pubs.acs.org/acsaelm Article

High-Temperature In Situ Investigation of Chemical Vapor Deposition to Reveal Growth Mechanisms of Monolayer Molybdenum Disulfide

Hao Xue,[£] Guozheng Wu,[£] Bojin Zhao, Di Wang,* Xiaoming Wu,* and Zhanggui Hu

Cite This: *ACS Appl. Electron. Mater.* 2020, 2, 1925−1933 Read Online

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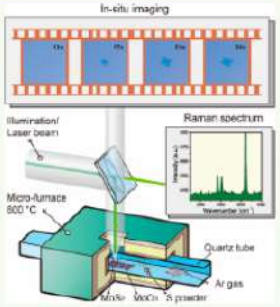
ABSTRACT: In situ investigation of chemical vapor deposition (CVD) is of critical importance to understanding growth mechanisms of transition-metal dichalcogenides (TMDs) and to develop technologies for growing high-quality monolayer single crystals. However, the in situ investigation is still a great challenge in practice, because TMD CVD growth is conducted at a high temperature with a reduction environment. In this work, we developed an in situ investigation system for CVD growth and presented real-time observations of monolayer MoS_2 deposition on the SiO_2/Si substrate. We discovered that monolayer MoS_2 should be grown via the vapor-state precursor reaction and crystallized from the prenucleation sites on a substrate, an intermediate-phase MoO_2 was essential for the nucleation seeding, but the population density should be controlled, and a high-concentration S vapor promoted the in-plane epitaxial growth of MoS_2; hence, it was of great benefit to obtain a high-quality monolayer with a compact shape.



KEYWORDS: *2D materials, in situ investigation, Raman spectroscopy, chemical vapor deposition, crystal growth mechanism, microfurnace, transition-metal dichalcogenides*

Micro-STS 1200 DEMO

https://pubs.acs.org/doi/abs/10.1021/acsaelm.0c00231

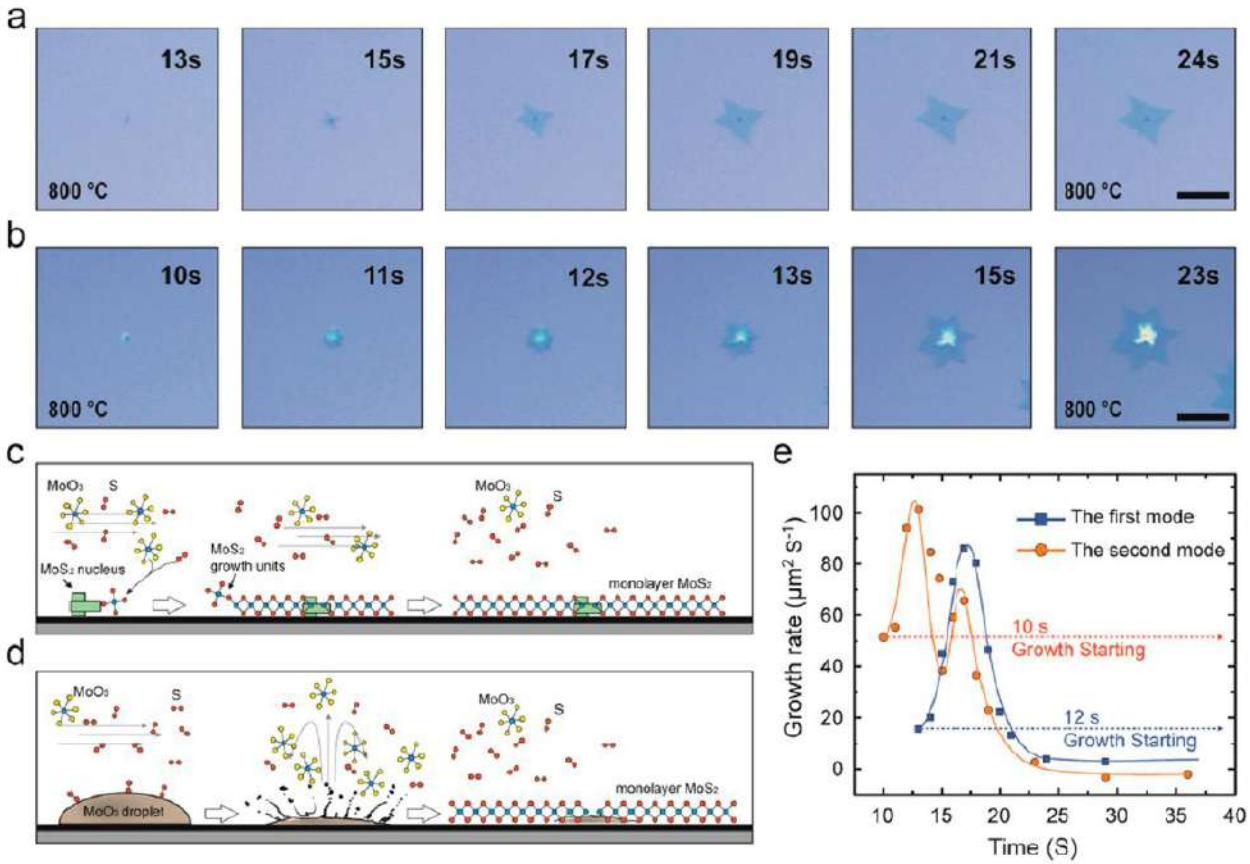


Figure 3. In situ optical images of monolayer MoS_2 grown on the epitaxy substrate at 800 °C. (a) The first growth mode: monolayer MoS_2 growth around a nucleation site. The scale bar is 15 μm. (b) The second growth mode: monolayer MoS_2 growth from MoO_3 droplets. The scale bar is 35 μm. (c) Schematic represents monolayer MoS_2 grown around a MoS_2 nucleation site, where the growth is fed by the vapor-state Mo sources. (d) Schematic represents monolayer MoS_2 from a MoO_3 droplet, where the growth is fed by the liquid droplet. (e) Time-dependent growth rates of monolayer MoS_2 by two modes. Two growth modes were recorded simultaneously in one substrate under a flow rate of 50 sccm.

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The study of the intermediate precursors in the MoS_2 growing process

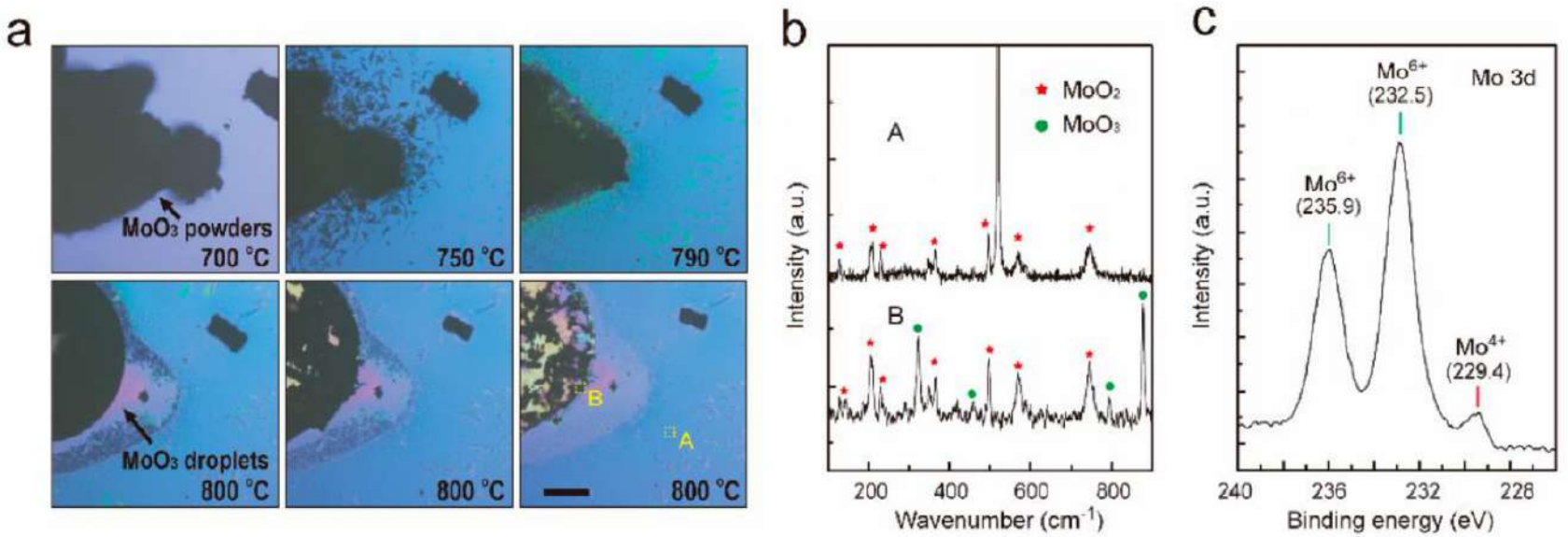

Figure 4. Suboxide MoO_2 deposition on substrate. (a) In situ images of MoO_2 film deposition on a SiO_2/Si substrate at high temperature. The scale bar is 80 μm. (b) Ex situ Raman spectra of the film and the residual droplet, collected from the points marked by yellow squares in (a). (c) Ex situ XPS spectrum of the deposited film with the X-ray spot size of 300 μm.

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Application2 Automated growth of CNT

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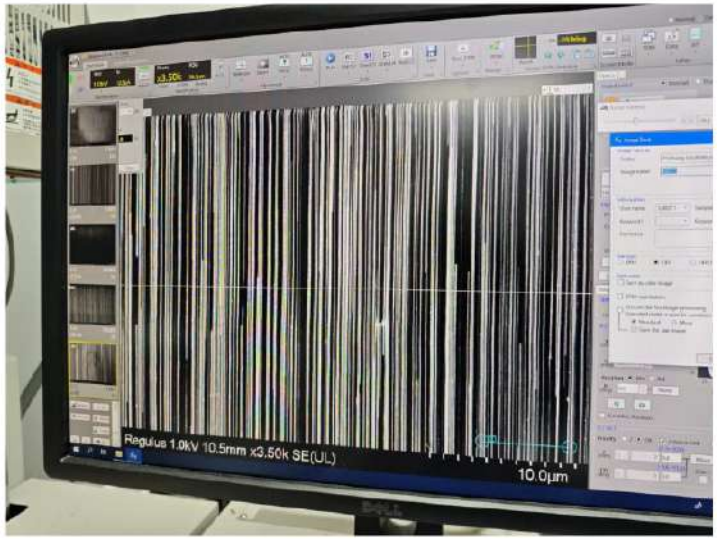

The research group of Academician Zhang Jin of Peking University has developed the "Peking University Carbon Nanotube Automatic Growth Platform" based on our company's products, which realizes 24-hour fully automatic, repeatable, and high-quality carbon nanotube preparation (30 furnaces/day), which is 10 times more efficient than that of traditional tube furnaces.

https://pubs.acs.org/doi/abs/10.1021/acsaelm.0c00231

Application3 The growth of the TMDC

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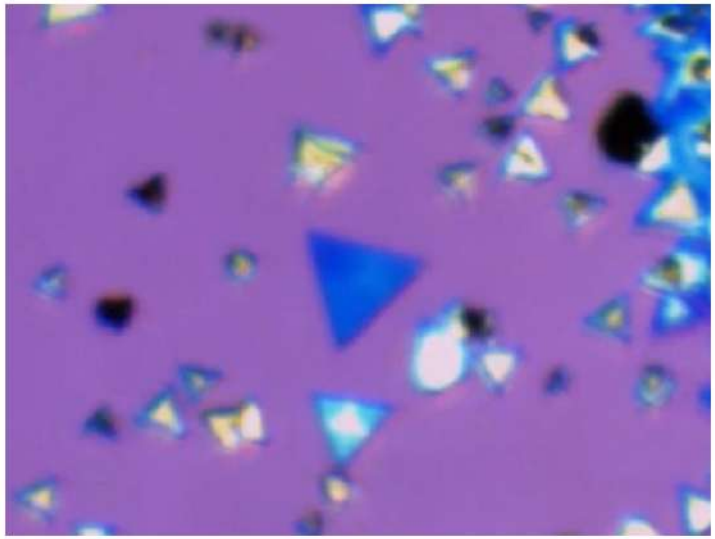

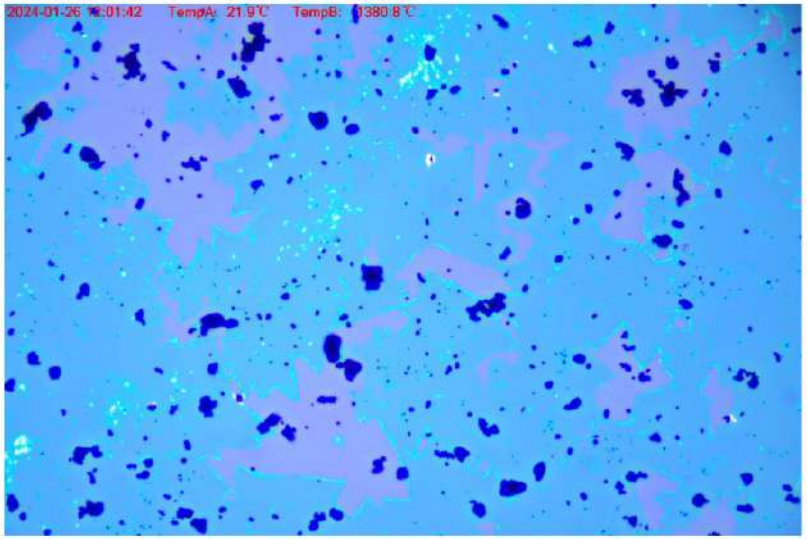

A doctor from a well-known university has never succeeded in growing the target object. After observing and recording the growth process through Micro-STS1200, he found that the target object has been generated during the growth process, but etched over time. Subsequently, through process adjustment, combined with the Micro-STS1200, and by observing and controlling various parameters while experimenting, the target material was successfully grown.

Application4 The observation of the metal transition

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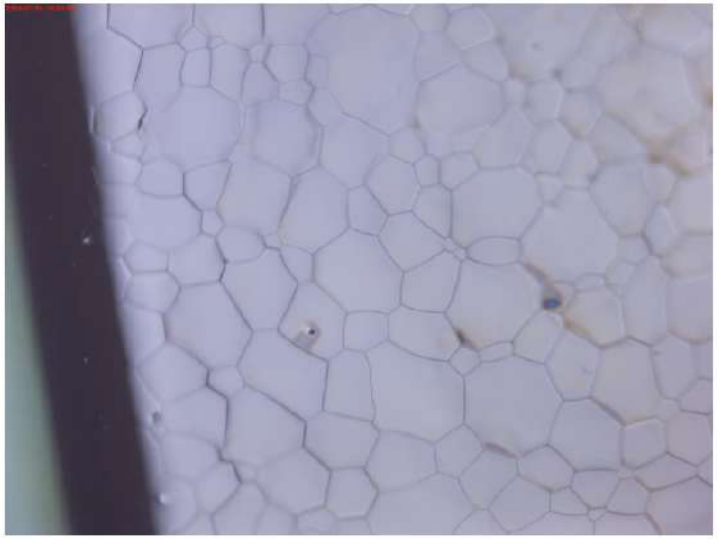

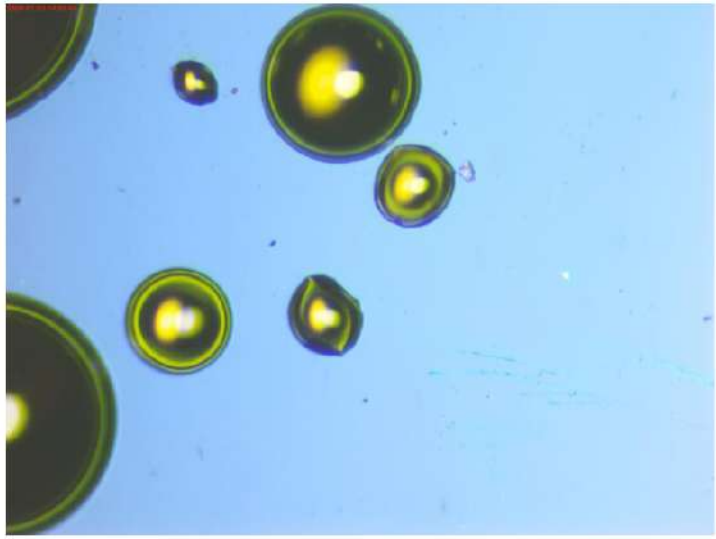

The Micro-STS1200 utilizes the characteristics of visualization, annular thermal field, controllable heating and cooling rates, and multi-atmosphere environments to observe, record and analyze the high-temperature phase change processes of metals and other substances in different environments.

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