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Design of MBE in-situ to LTSTM for TMD Thin Film Growth & Characterization

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Introduction

• MBE Components:

- UHV Chamber: high mean path of evaporated atoms
- Electron gun: materials having higher melting point
- Effusion Cell: material with low melting point
- Manipulator: Facilitated with substrate heating
- RHEED: Monitor layer by layer growth on substrate
- QCM: measures a mass variation per unit area

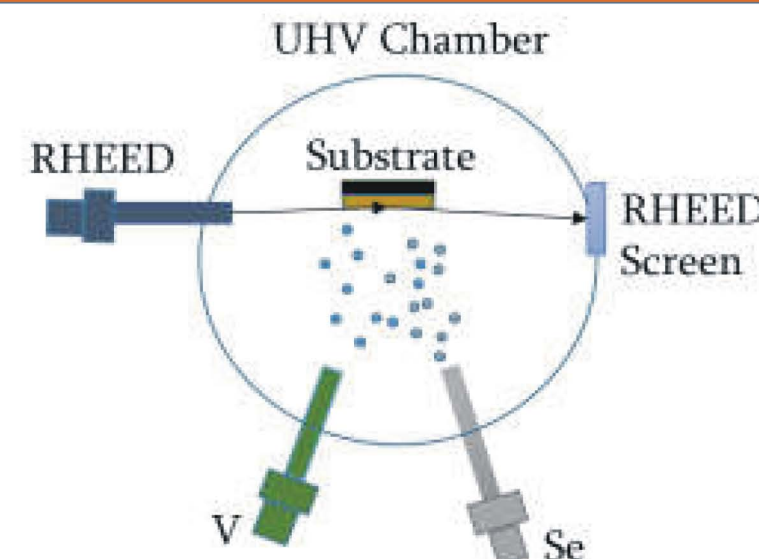
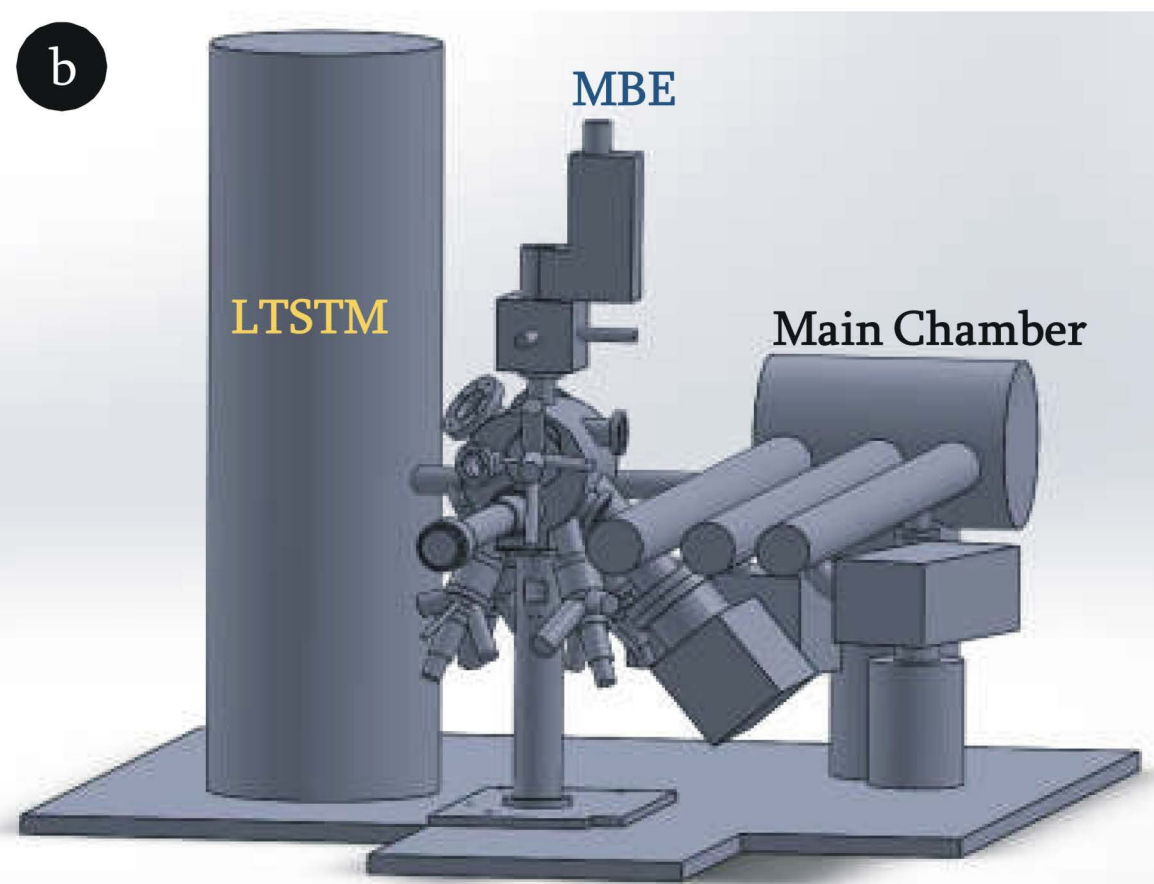
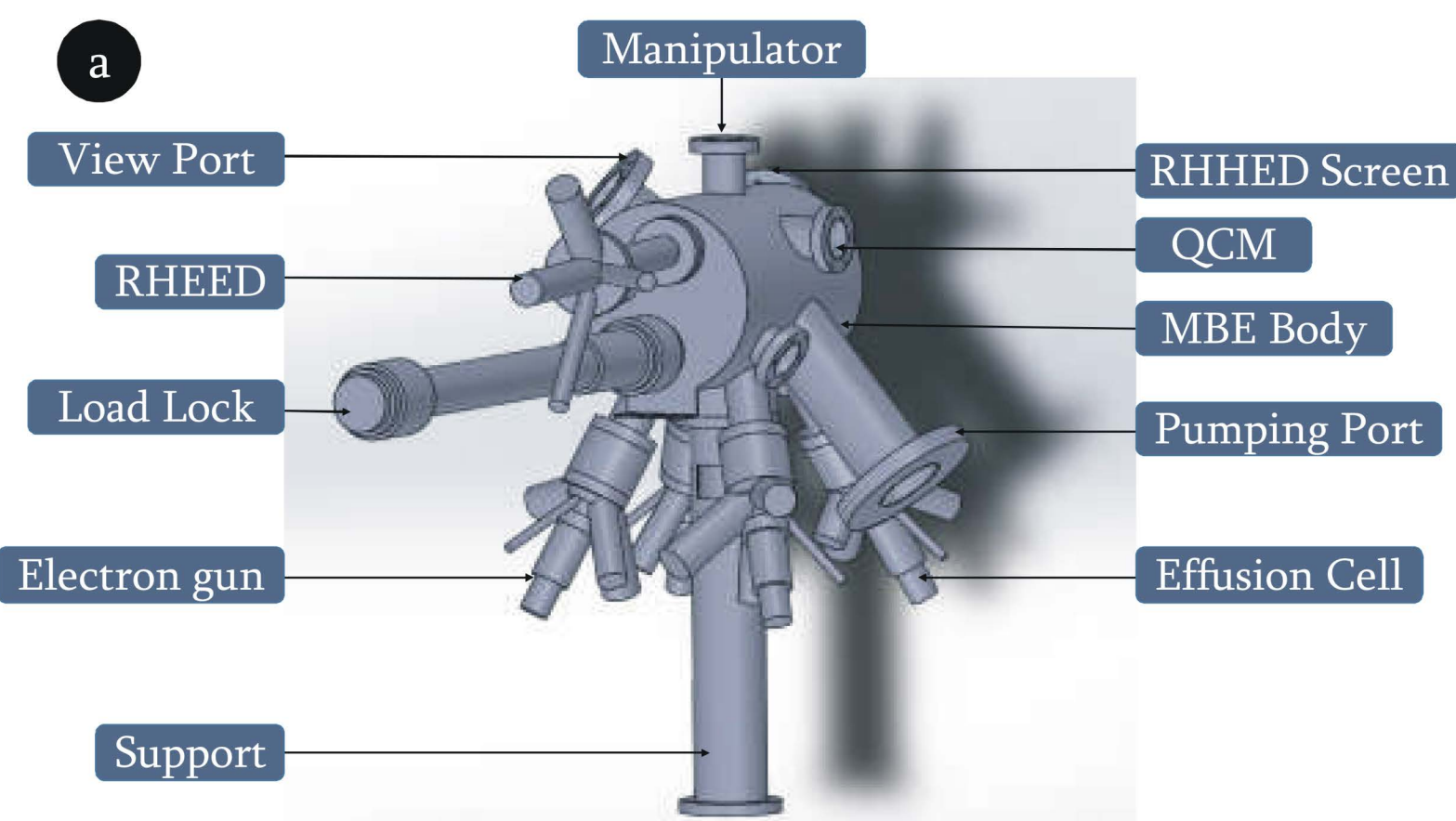


Fig 1: Schematic View of working of MBE setup

• MBE Capability:

- Precise control of growth parameters
- Best suited for thin films growth
- Fabrication of artificial heterostructures
- In-situ to LTSTM can facilitate study of
 - low dimension phase transition
 - Local density of state
 - Transition temperature
 - Symmetry breaking

MBE Solidworks Design



• MBE Specification:

- length 25x20 dia in cm
- Two transition metal electron gun (V, Pt)
- Two Knudsen effusion cell for chalcogens (Se, Te)
- Sample annealing upto 500°C
- Motor controlled manipulator motion

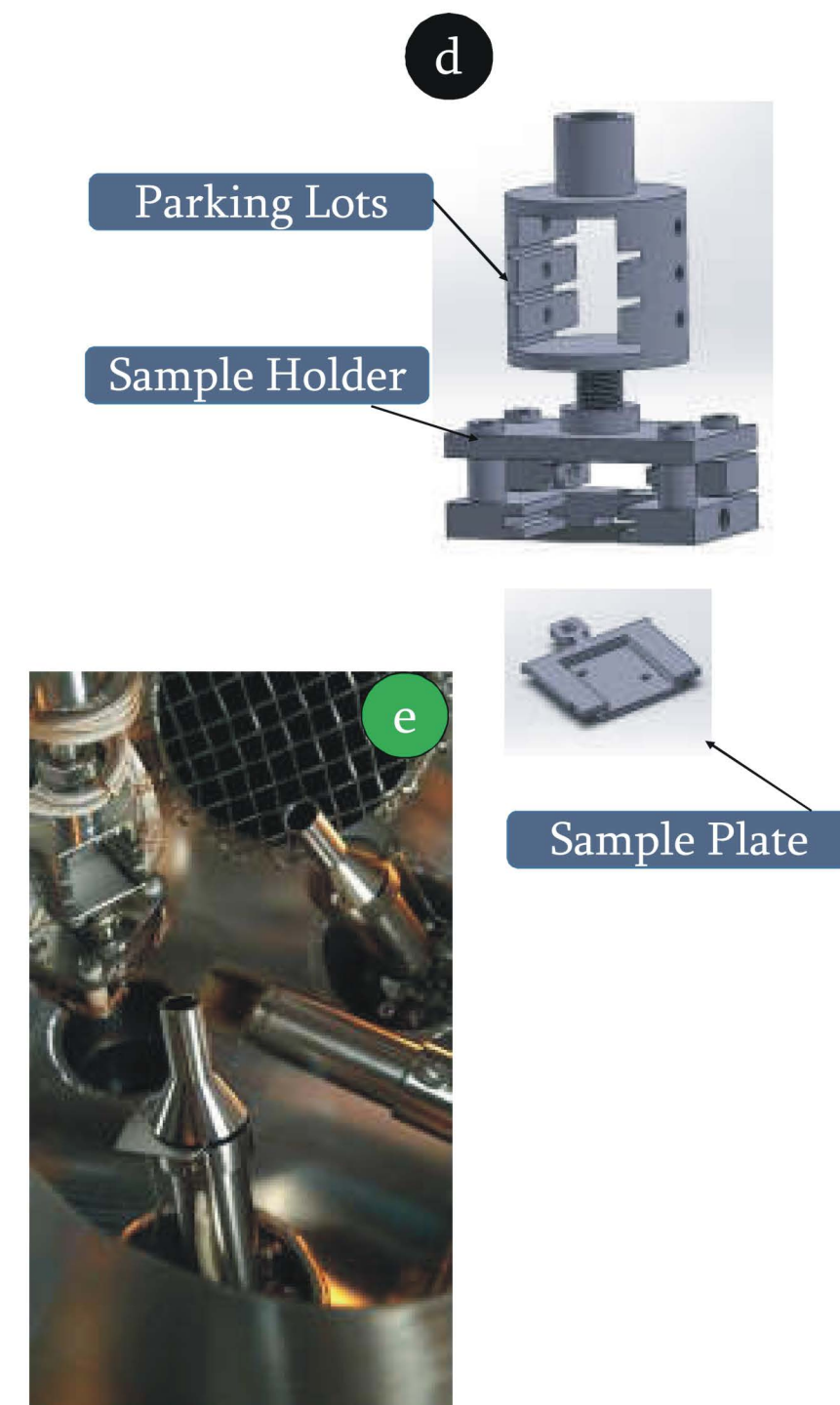
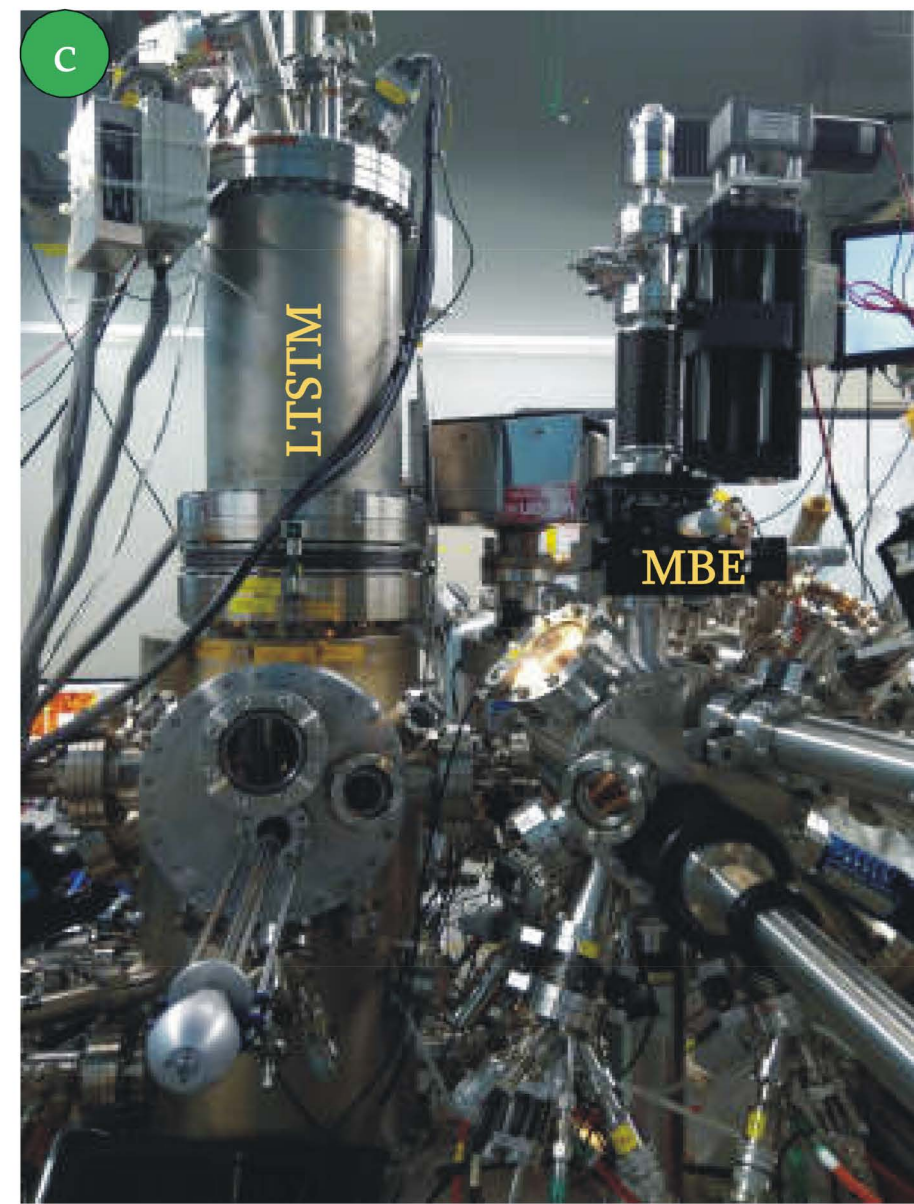


Fig 2: (a) schematic view of chamber design along with its equipment (b) Model of MBE in-situ to LTSTM (c) MBE completely assembled and installed besides LTSTM chamber (d) Model of manipulator, parking lots and sample plate (e) parking lots, electron gun, manipulator & load lock grabbing sample

MBE Sample Growth and STM Characterization

- VTe₂ a type of TMD material is grown on HOPG substrate.
- Growth Parameters: V:Te = 1:10; Substrate temperature: 280°C; Chamber Pressure: 2.5E-9 torr

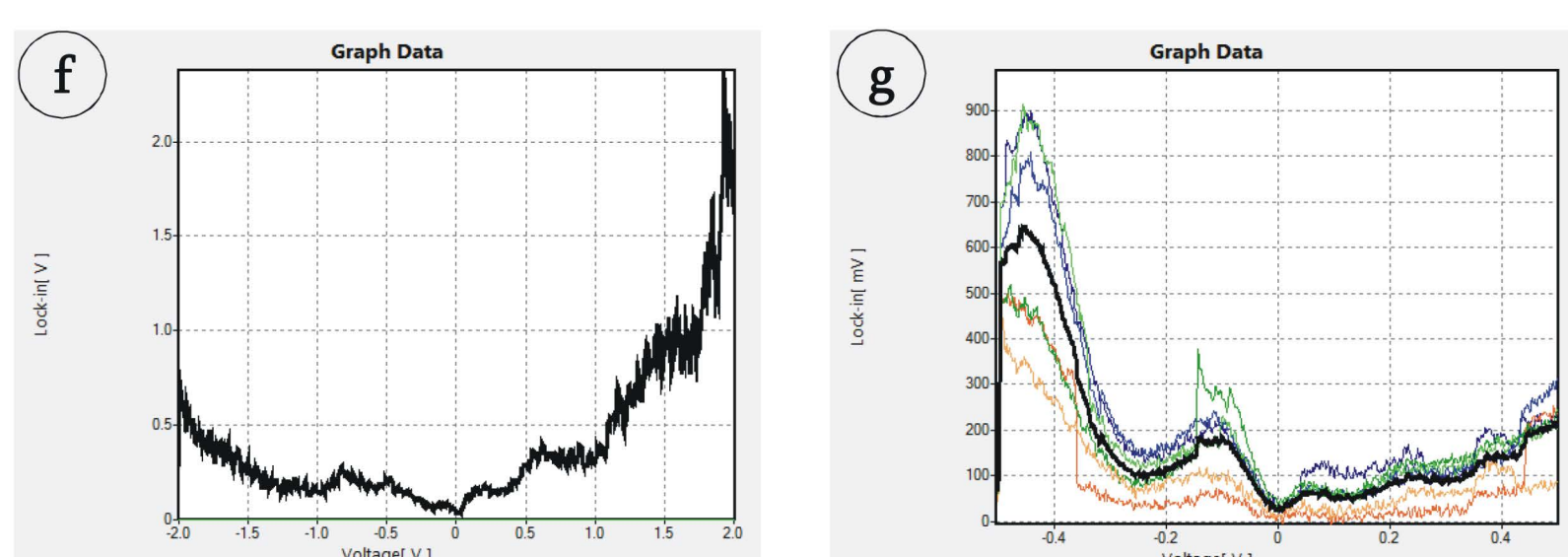
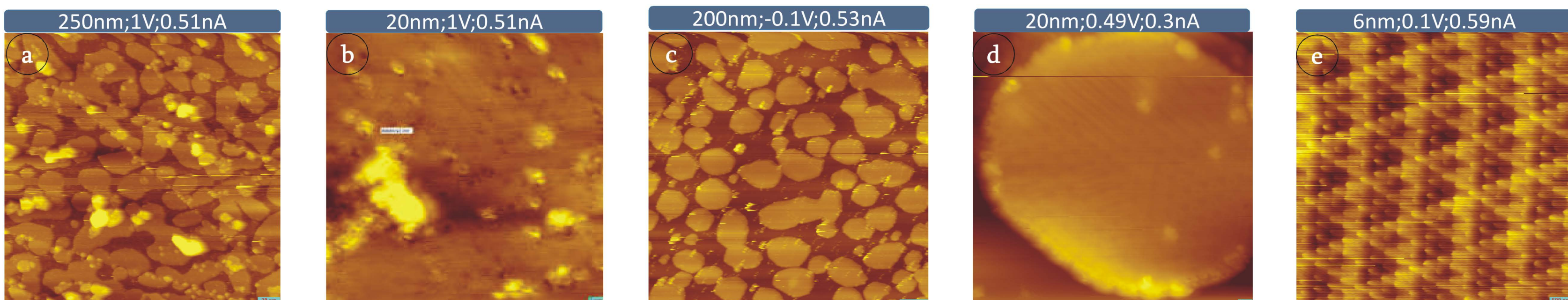


Fig 3: STM image at 78K (a,b) first batch 1ML VTe₂ and (c,d,e) second batch 1ML VTe₂ on HOPG substrate, (e) atomic resolution showing 4x4 reported CDW supercell of VTe₂ monolayers, (f,g) STS on monolayer island

• Conclusion:

- Successful design & installation of MBE in-situ to LTSTM
- Instrument testing and calibration is successfully achieved
- 1ML 1T-VTe₂ is successfully grown with reduction in contamination and defects
- LTSTM characterization reveals CDW symmetry and LDOS of 1ML VTe₂



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