Preparation of $SrTiO_3$ single crystals for TiO_2 thin film deposition

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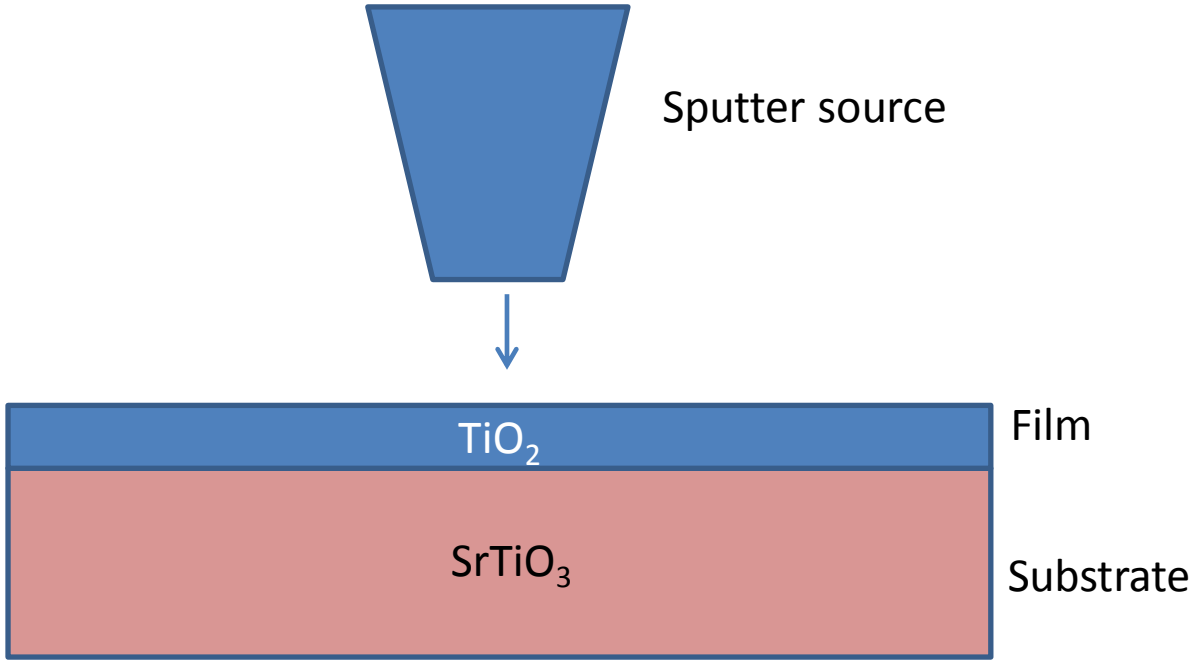
Outline

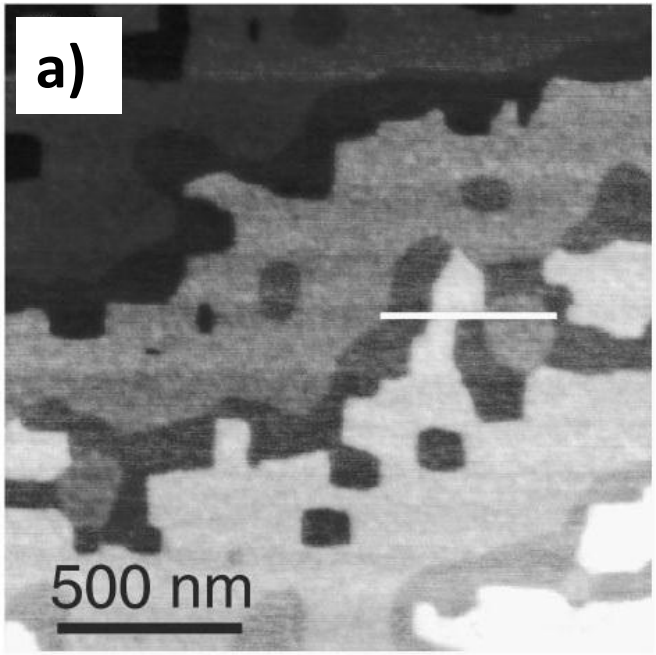
- Motivation
- State of the art
- Workplan
- Results

Motivation

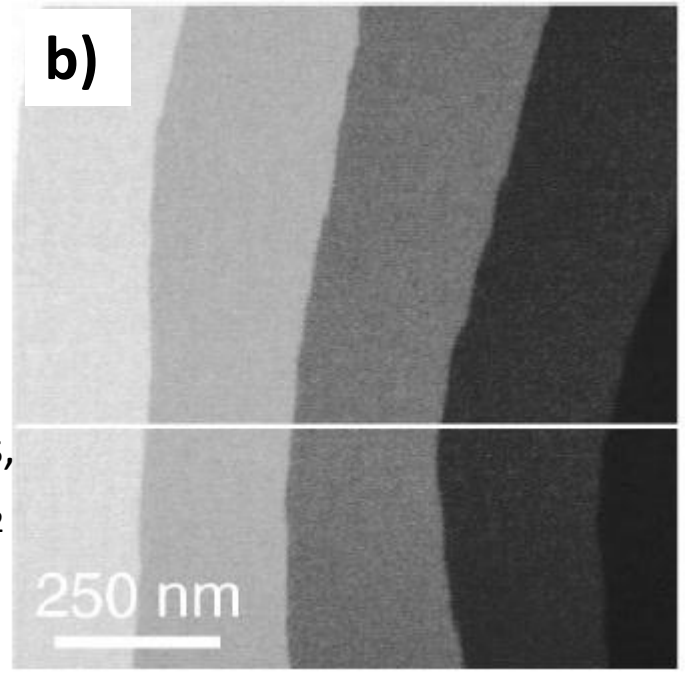
- Creation of regularly shaped atomic like stepped $SrTiO_3$ surfaces
- For smooth morphology of TiO_2
- For epitaxial orientation of TiO_2



State of the art



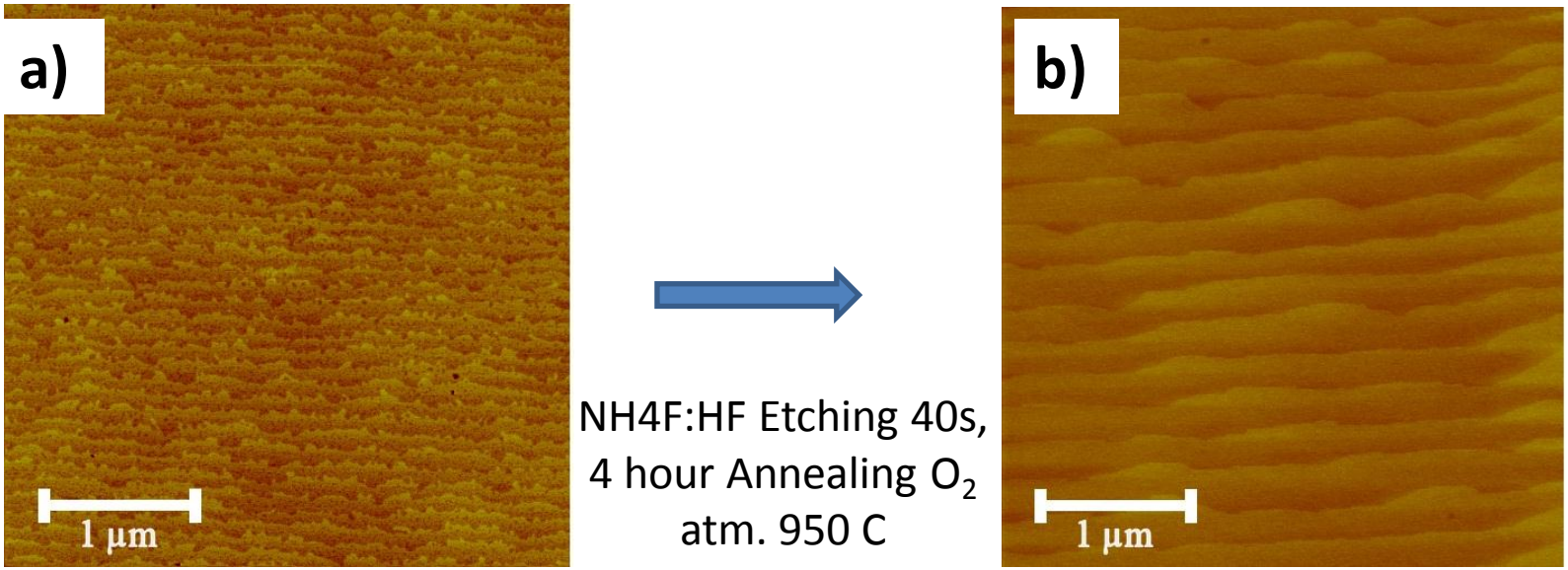
NH4F:HF Etching 30s,
1 hour Annealing O_2
atm. 950 C



The lattice of SrTiO3 consists of two sub-lattices of SrO and TiO2, layered alternately. To facilitate well controlled epitaxial growth on STO substrates, it is better to have a single surface termination with atomically flat terraces

Quasi-ideal strontium titanate crystal surfaces through formation of strontium hydroxide, *Koster et. al. APL 73(1998)20*

State of the art



Magnetische Eigenschaften von metallischen Grenzflächen und Strontiumtitanat, *Armin Haase, 2011, Dresden*

Workplan

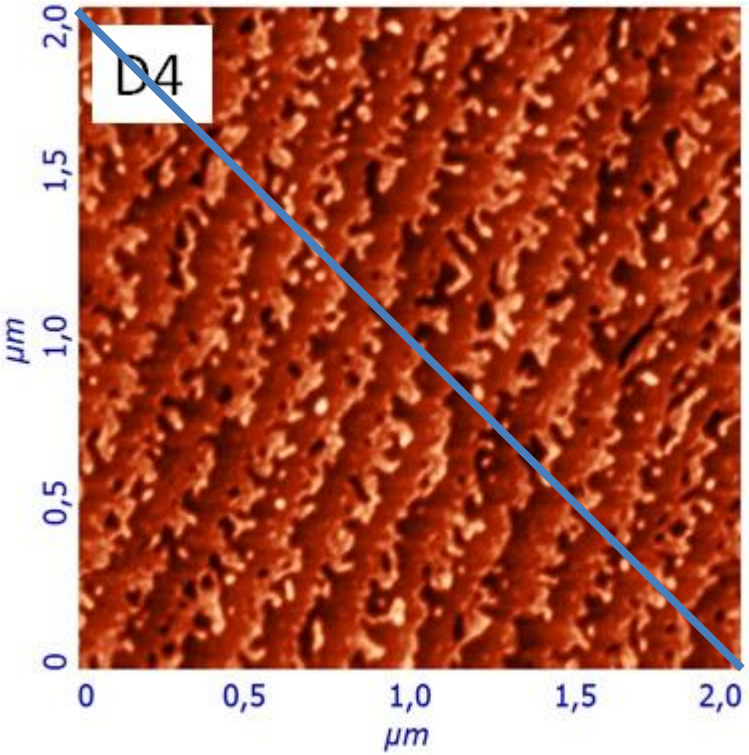
- Cleaning with Deionized water for 10 minutes

- Etching with NH4F:HF=87.5:12.5, pH=5.5.
    - Variation of etching time (0 s, 20s, 40s, 60s)

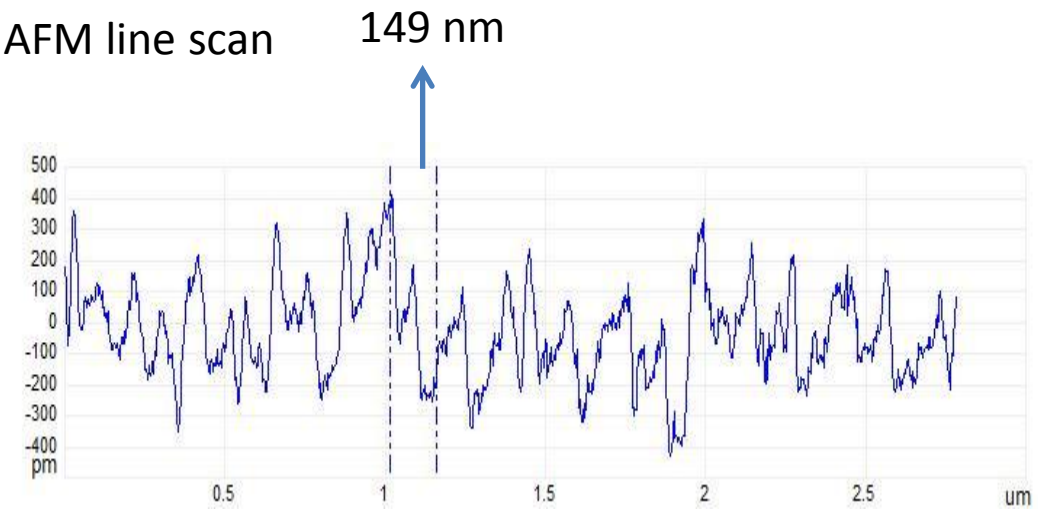
- Annealing in O_2 atmosphere (7 l/min flow, 950 C)
    - Variation of annealing hold time (1h, 4h)
    - Atomic Force Microscopy (AFM)

Results

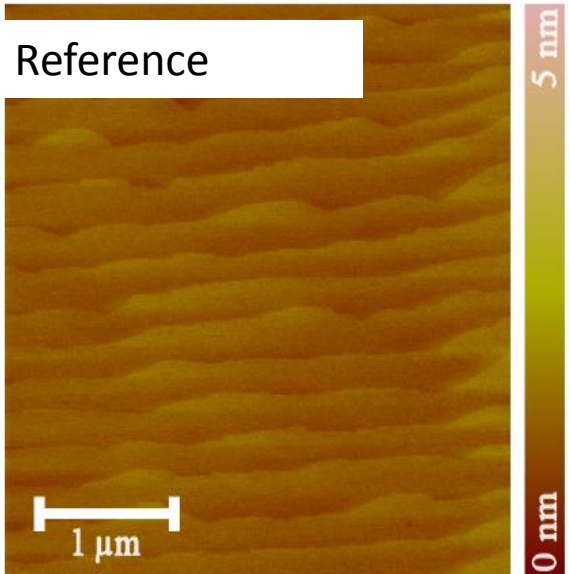
AFM image



AFM line scan

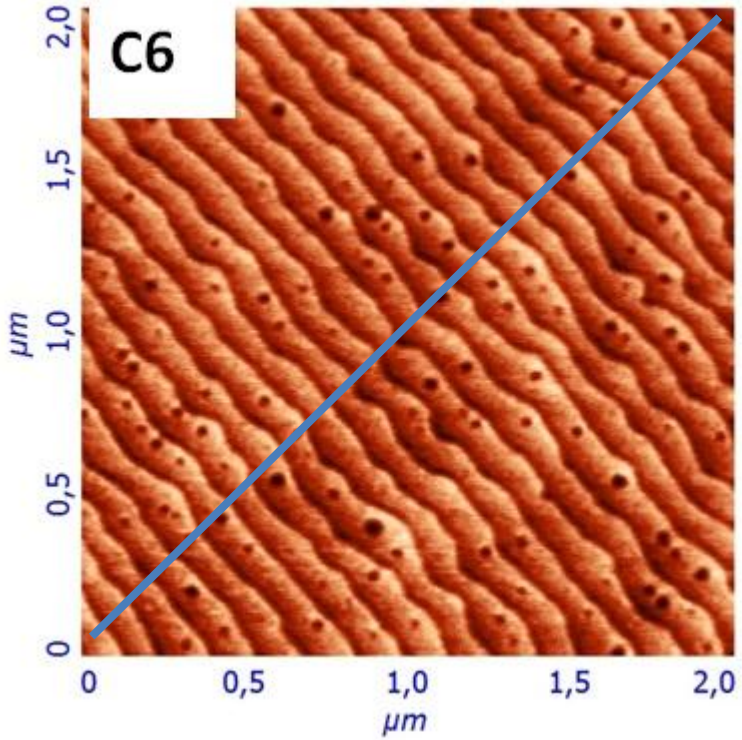


Sample D4
- No ultrasonic cleaning and no etching
- Annealing: 1 hour

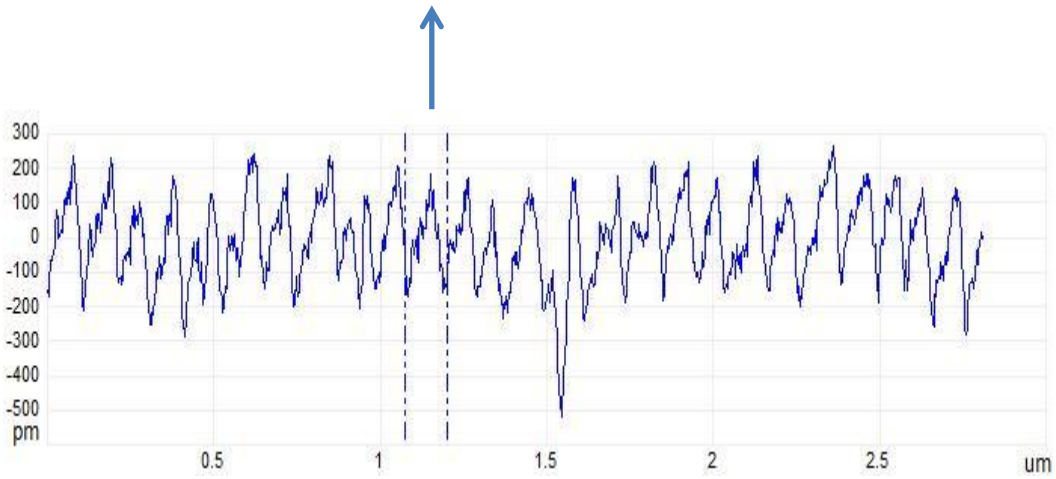


Results

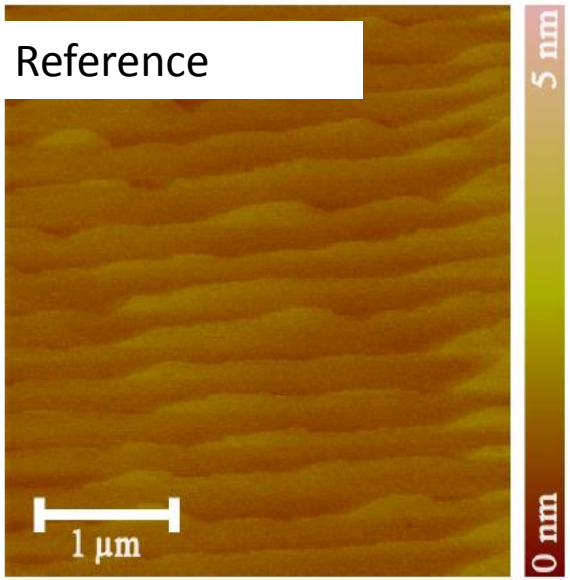
AFM image



AFM line scan

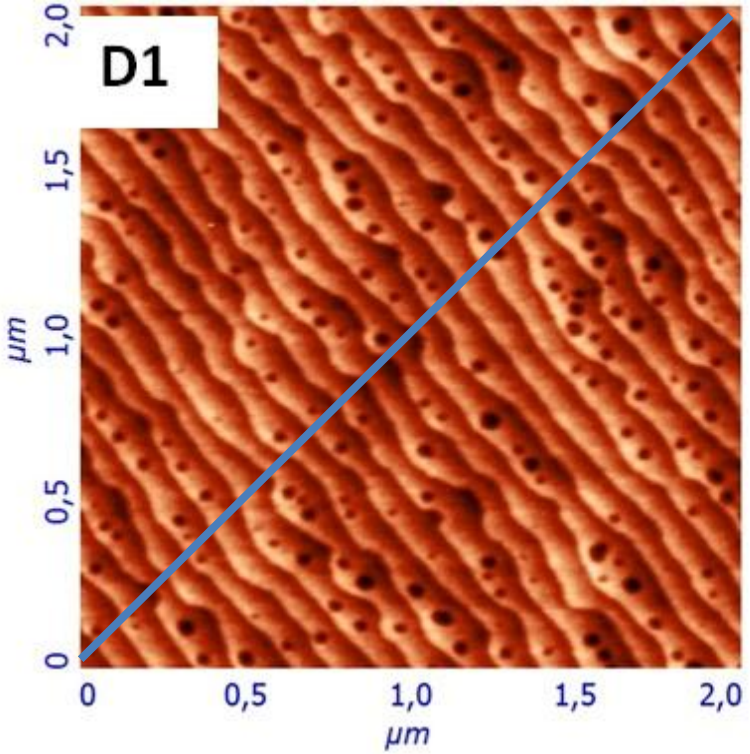


Sample C6
- 10 mins Ultrasonic cleaning, 20 s etching
- Annealing: 1 hour

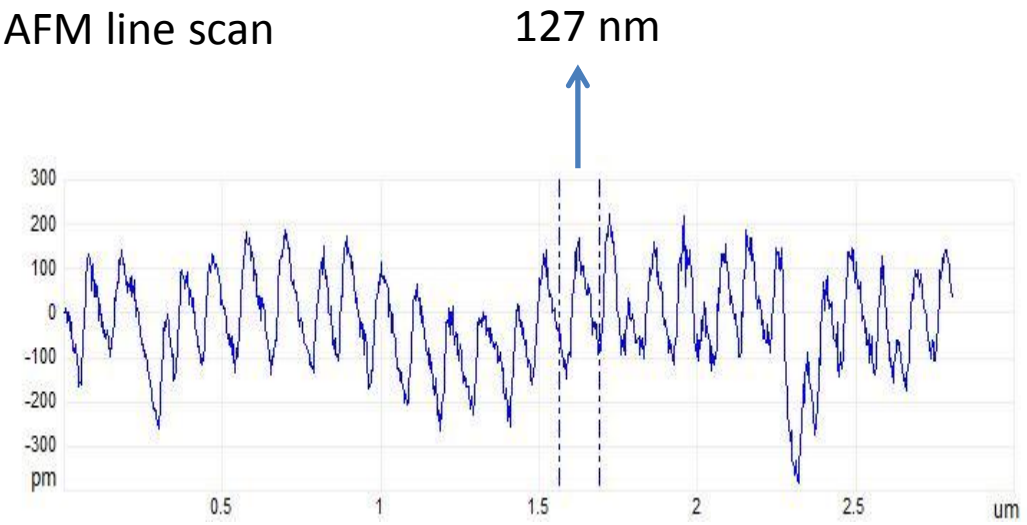


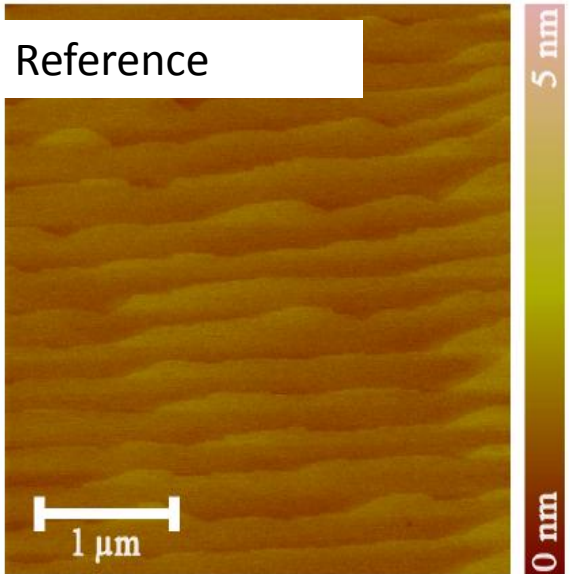
Results

AFM image



AFM line scan

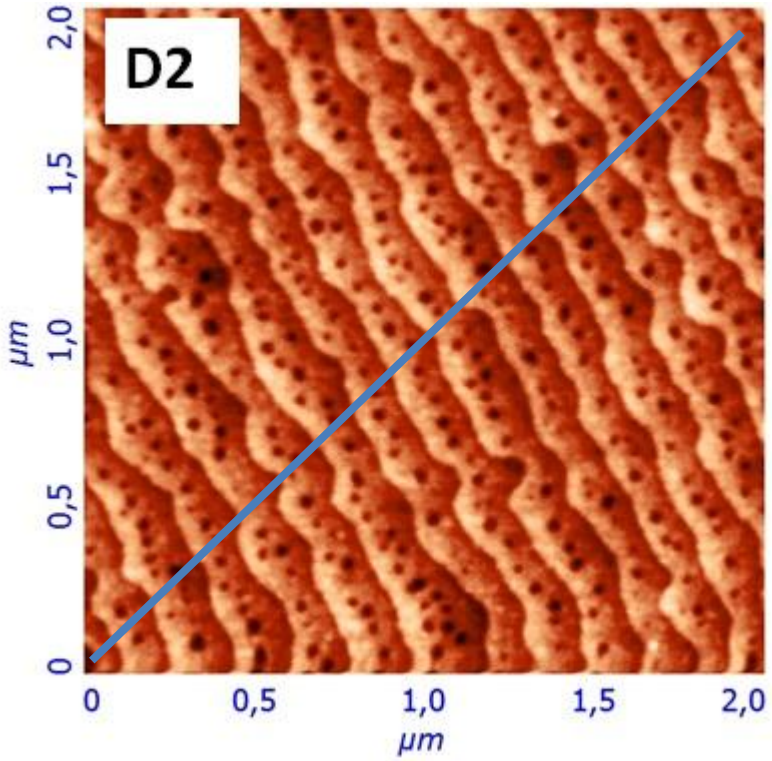




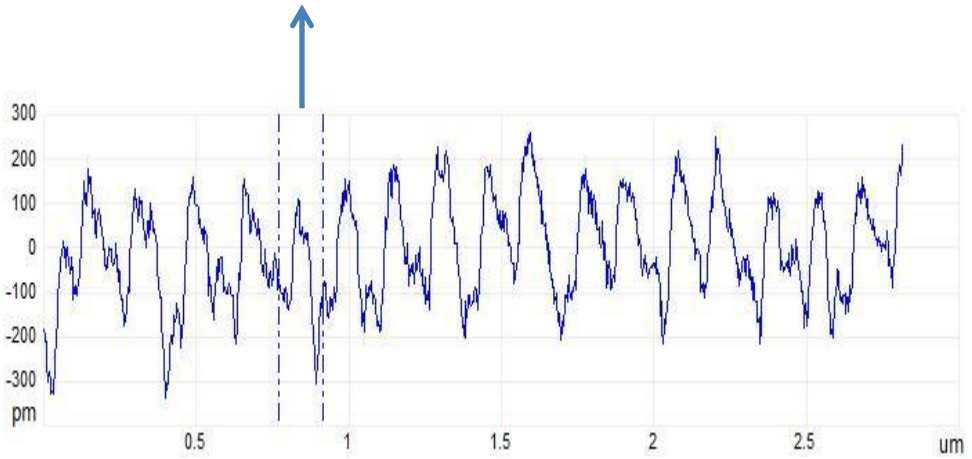
Sample D1
- 10 mins Ultrasonic cleaning, 40 s Etching
- Annealing: 1 hour

Results

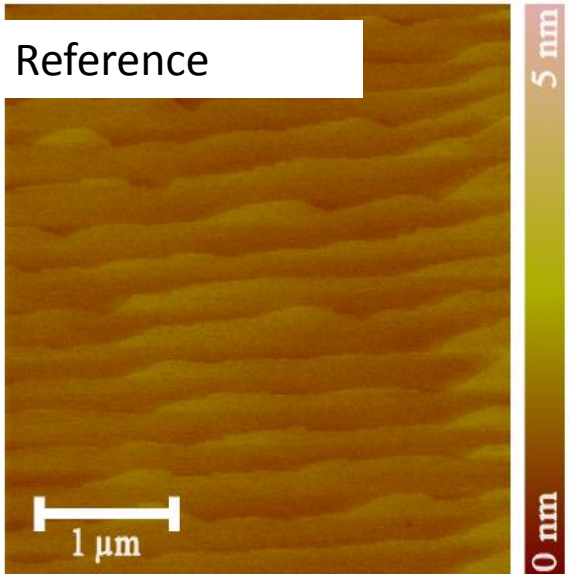
AFM image



AFM line scan 144 nm

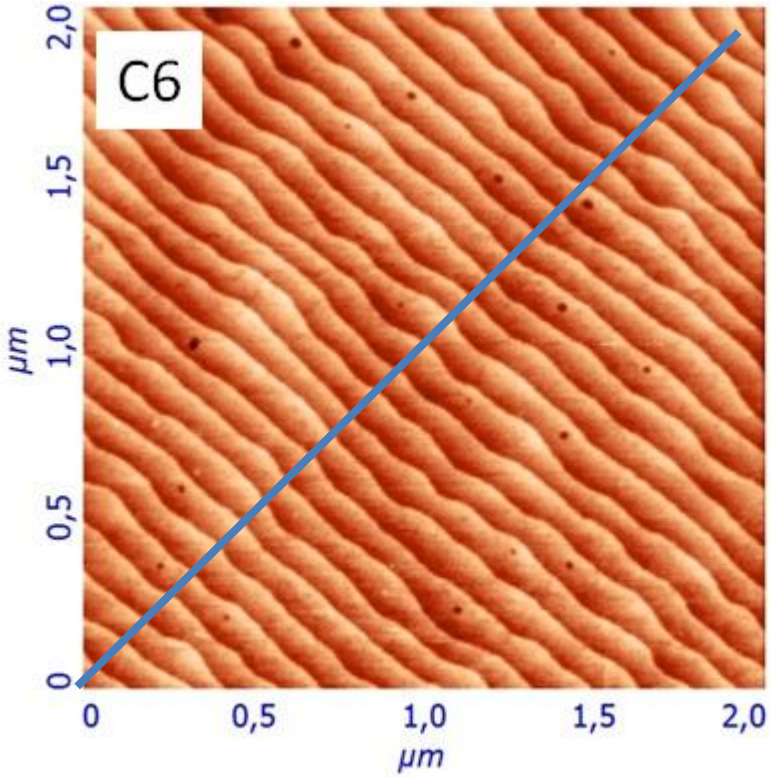


Sample D2
- 10 mins Ultrasonic cleaning, 60 s etching
- Annealing: 1 hour

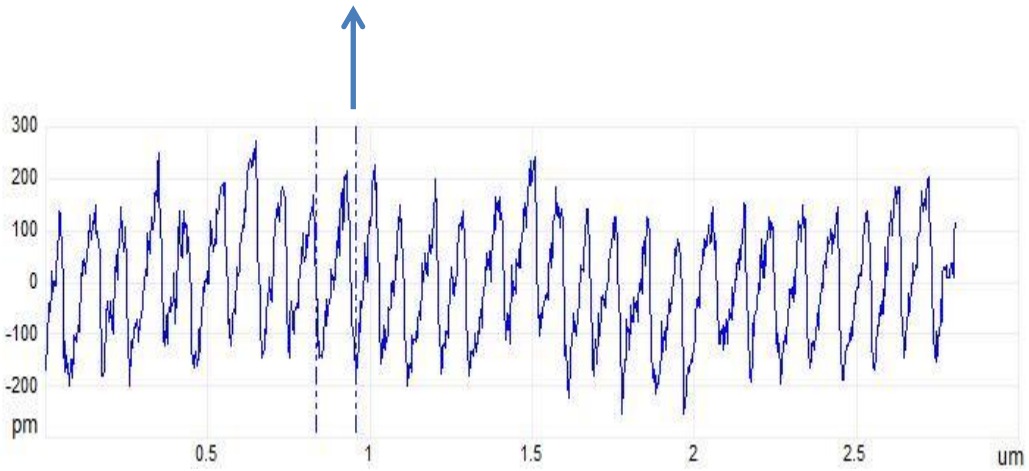


Results

AFM image

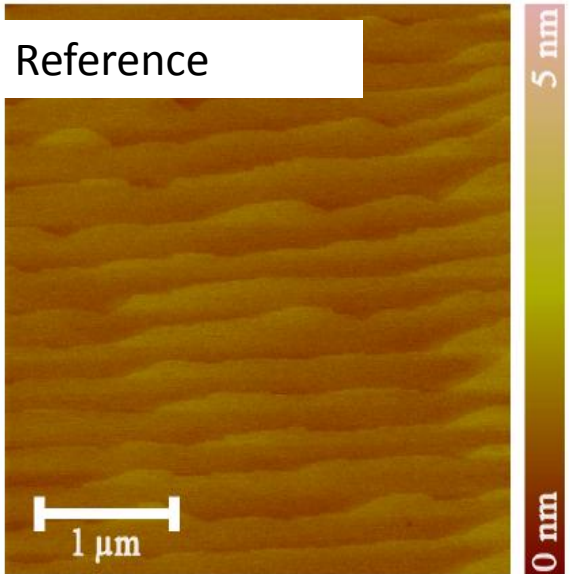


AFM line scan 122 nm

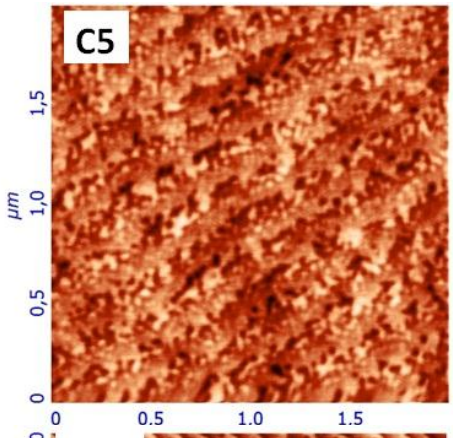


Sample C6

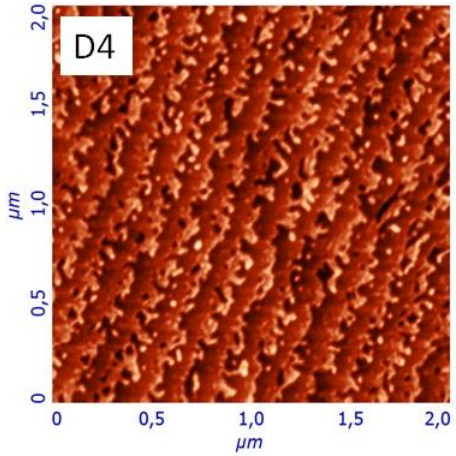
- 10 mins Ultrasonic cleaning, 20 s etching
- Annealing: 4 Hour



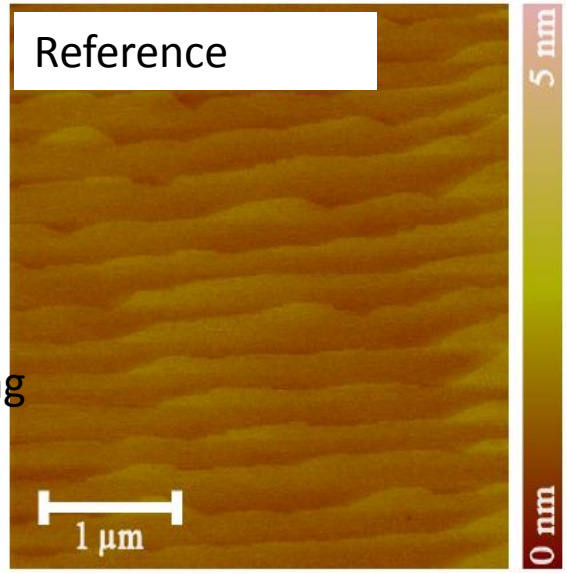
Results

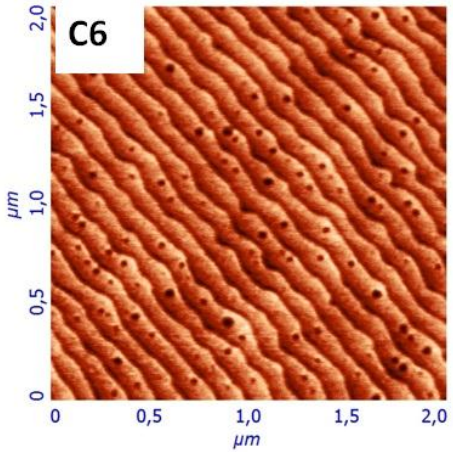


No etching, no annealing



No etching, 1 hour annealing

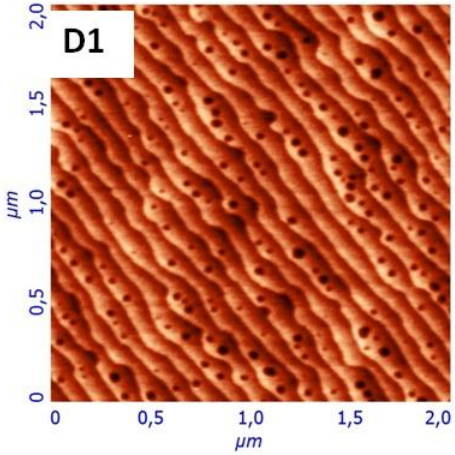


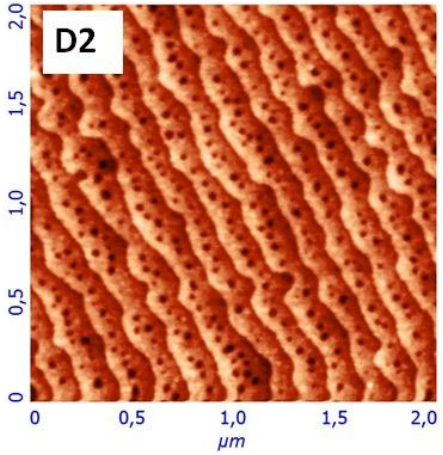


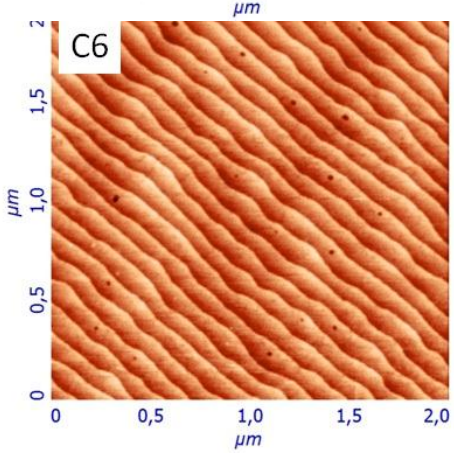
20 s etching, 1 hour annealing

40 s etching, 1 hour annealing

60 s etching, 1 hour annealing

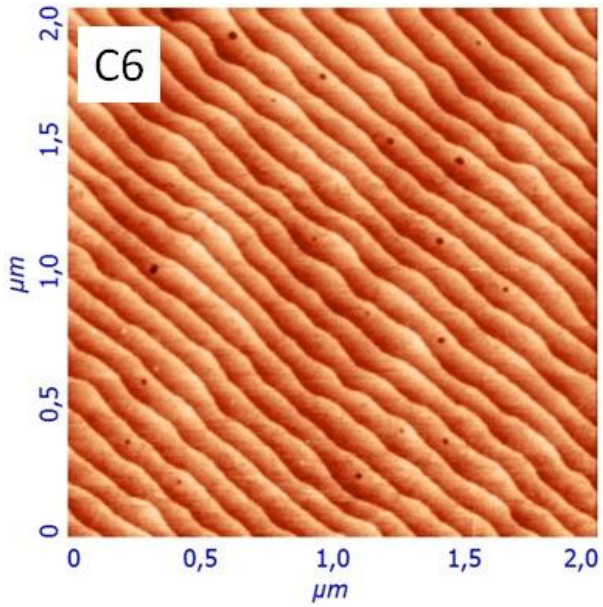




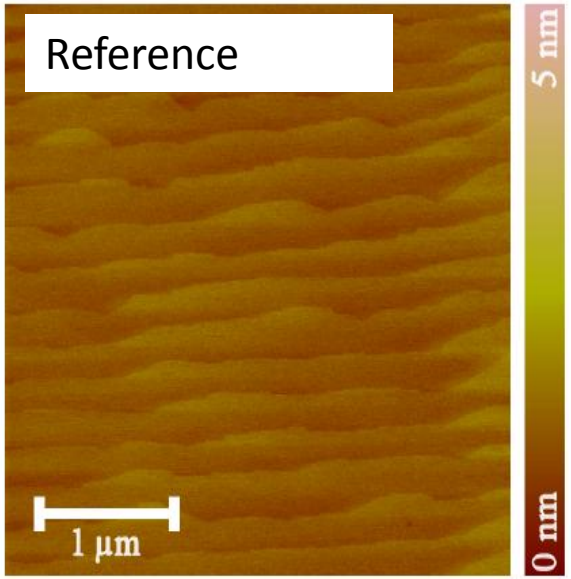


20 s etching, 4 hour annealing

Results



4 hour annealing



Optimized Results: 10 minutes ultrasonic cleaning, 20s etching and 4 hours annealing!!!