**Goal**

In-situ analysis of morphology induced surface scattering phenomena via resistance measurements.

**Bi/Si(001)**

**Growth at 150 K**
- In-situ measurements of the resistance and LEED (00)-spot intensity during deposition of Bi on Si(001) at 150 K.
- Quasi-bulk growth > 5.6 BL [1].
- Slope of the resistance curve changes with changing the crystal phase.
- At 5.6 BL coverage, quasi-12-fold symmetry LEED pattern and a ring of intensity surrounding it.
- \( \approx \) ordered (111) & rotationally disordered (110) crystallites.
- Ring disappears at higher coverage.

**Additional Bi deposition at 450 K**
- Capping of height undulation.
- Average terrace size > 400 nm.
- No defects and surface contamination [3].

**Ex-situ film characterization**

**AFM**
- 3 fold symmetry Bi islands.
- Twins \& rotated islands.
- Low density of screw dislocations.

**XRD**
- Film relaxed to bulk (d_{Bi} = 0.394 nm).
- Kossel fringes [4].
  - ||,edge\(^{\|} = 0.377 nm = (6.6 ± 0.3) nm.
  - \(< \theta > = 11 nm\) & \(< \theta > = 14 nm\) [4].

**Bi/Bi(111)**

**(00)-spot intensity oscillation at 80 K.**
- \( < L > \) \& island density \((< L > \sim < \theta >^{1/3})\) [11].

**Bi/Si(001) and Bi/Bi(111) and M. Horn von Hoegen, Phys. Rev. B 76, 035337 (2007).**

**Morphology**

**Vertical roughness**
- Periodic change of central spike from one in-phase condition to the next one.
- Spike vanishes at out-of-phase, showing only shoulders.
- Total intensity is conserved.
- 2D island distribution.
- Normalized central spike intensity G(S) of the LEED (00)-spot profile as a function of scattering phase S.
- The curves fitted with 2D model, i.e., cosine behavior [7].
- Island height: \( d_{\text{Bi}} = 0.389 \text{ nm at } 80 \text{ K} \) and \( d_{\text{Bi}} = 0.395 \text{ nm at } 140 \text{ K}\) [8].
- Observation of the electron density smoothing effect for small islands (Smoluchowski effect) [9].

**Lateral roughness**
- Horiz ring at 0.5 BL coverage.
- Well-defined terrace size distribution [10].
- Ring diameter decreases with increasing the deposition temperature.
- Island separation increases.
- Quasiisodopic island shape (kinetic limitation of edge diffusion).

**Surface diffusion barrier**
- Arrhenius plot of the average island separation \(< L >\) and the island density \((< L > \sim < \theta >^{1/3})\) [11].

**< L > = \exp \left( \frac{E}{k T} \right)\)**

- The slope of the fit gives an intraterrace diffusion energy of \( E_{\text{diff}} = 135 \text{ meV} [8]\).

**Annealing to 450 K**
- Ring disappears during Annealing (at \( T \approx 230 \text{ K}\)).
- Spot splitting in LEED \& height contrast in STM.
- Periodic surface height undulation via interfacial misfit dislocation network [2].
- Average dislocation distance \( = 1.9\% \text{ BZ} (\approx 20 \text{nm})\).

**Bi/Si(001)**

**Annealing behavior (80 K - 450 K)**
- (00)-spot profile variation during the annealing.
- Central spike increases in the expense of shoulder.
- Shoulder diameter decreases after \( 220 \text{ K}\).
- Rapid increase of island separation at \( 220 \text{ K}\).

**References**