# Thickness mapping and layer number identification of exfoliated van der Waals materials by Fourier imaging micro-ellipsometry


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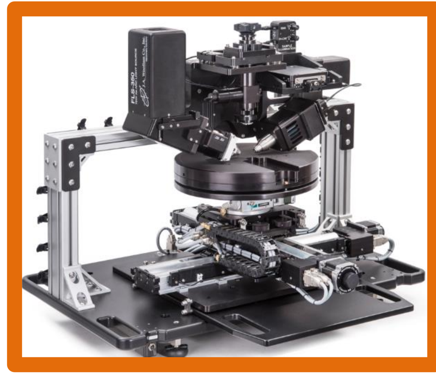
## 1) Spectroscopic Ellipsometry

- Optical technique for thin film characterization
  - Complex refractive index ($n$ and $k$)
  - Thin film thickness (sub-angstrom accuracy)

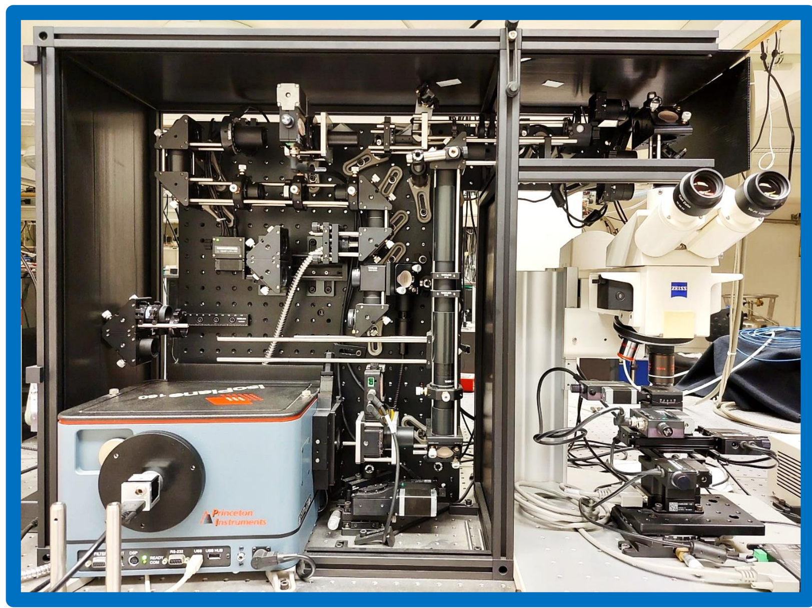
**High lateral resolution Spectroscopic Ellipsometers (SEs)**

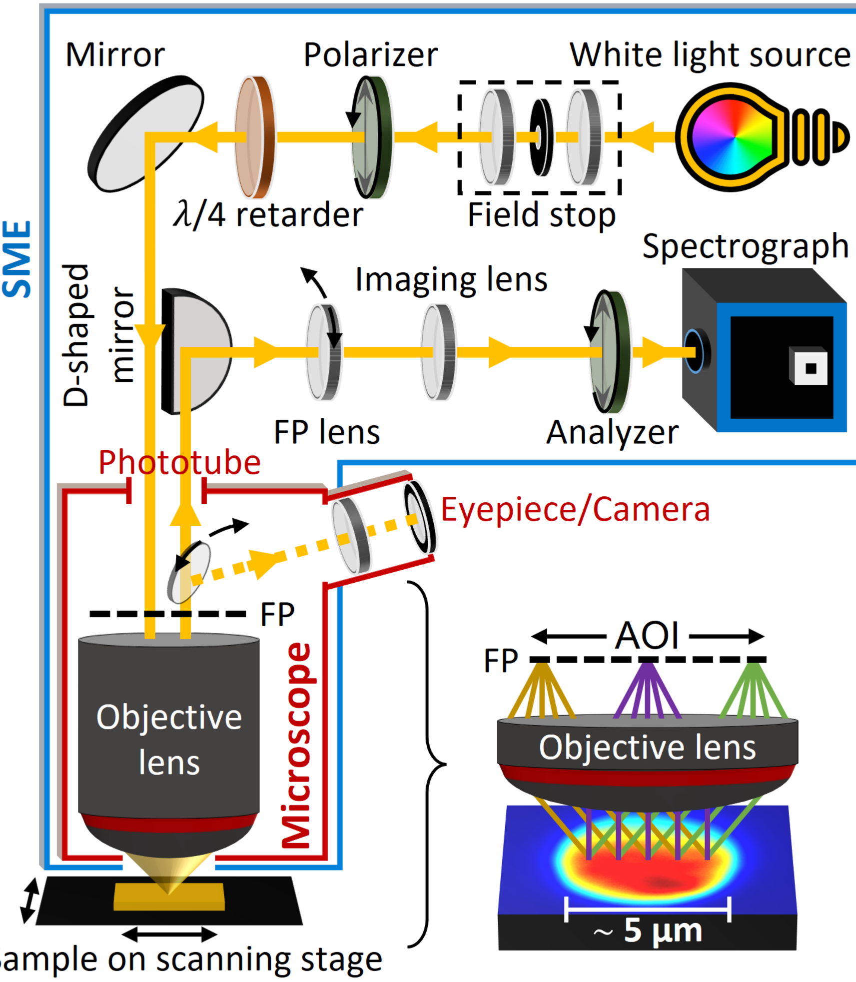


| | Focused-beam SE | Imaging SE |
|---|---|---|
| Lateral Resolution | Tens-of-µm (Low) | A few µm (High) |
| Acquisition per measurement | Broadband, SINGLE angle (Low) | SINGLE λ, SINGLE angle (Very low) |

**Challenging to measure micro-structures**

## 2) Spectroscopic Micro-Ellipsometer (SME)





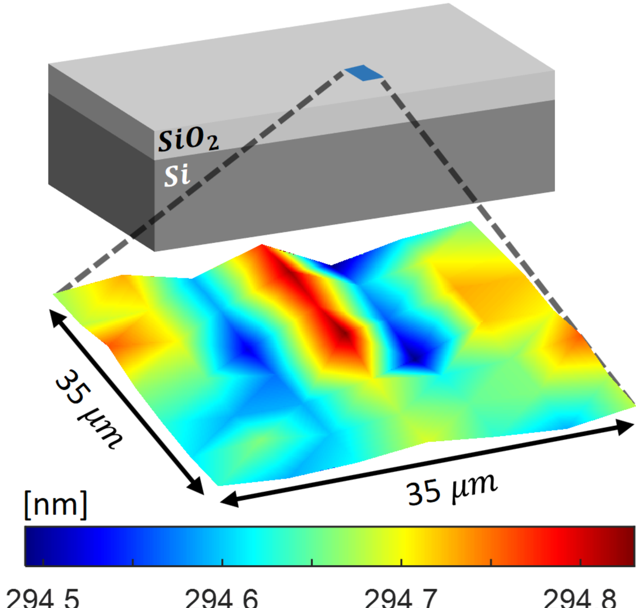

- Patented technology **[1]**
- Proven accuracy **[2]**
- Microscope-integrable
- Fourier-plane imaging

**High lateral resolution**
A few µm
Down to 2 µm

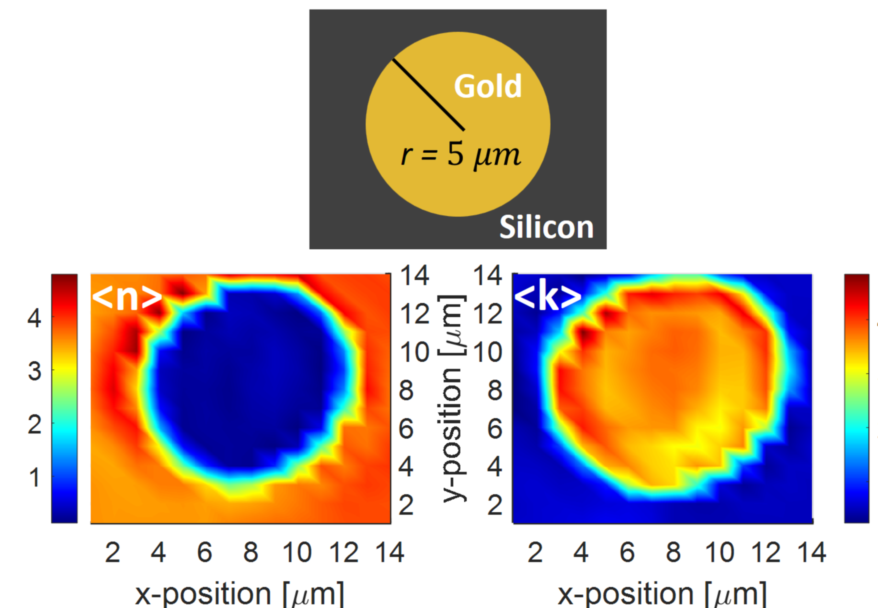
**Record high acquisition per measurement**
Broadband, MULTIPLE angles

### High lateral resolution mappings

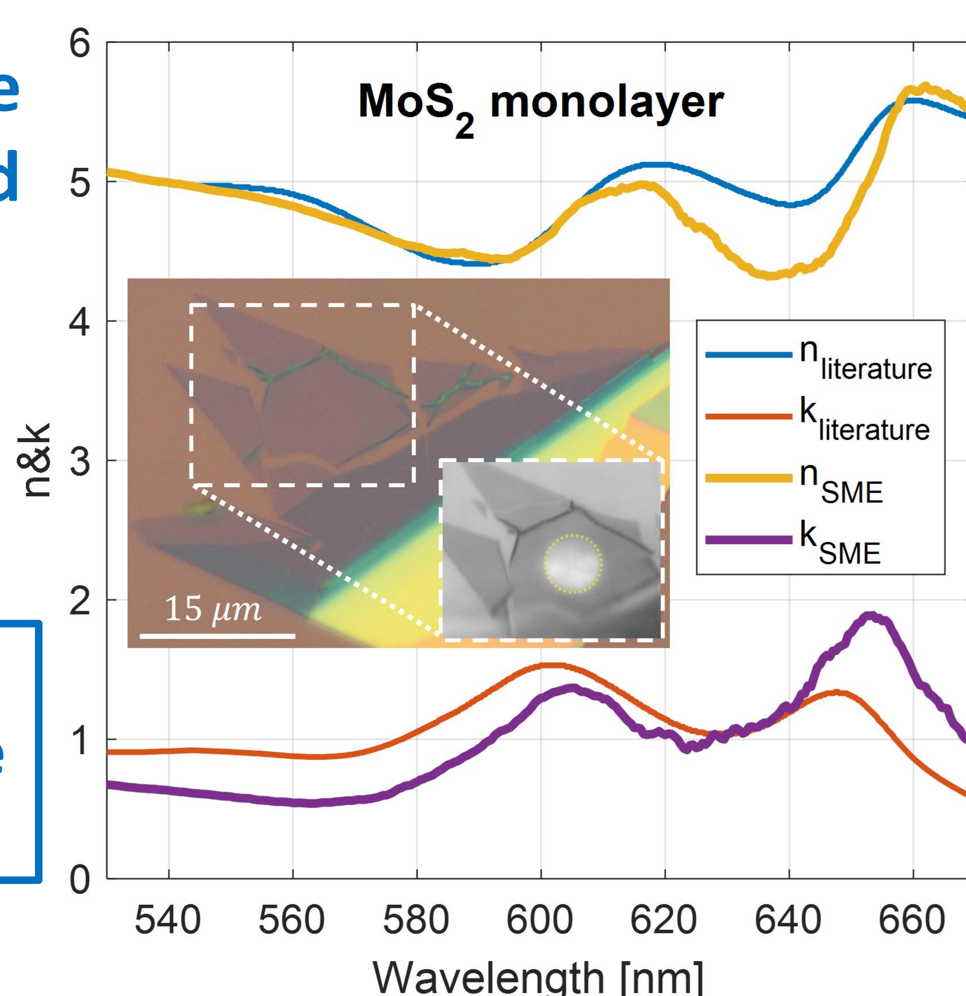
$SiO_2$ thickness mapping




Pseudo complex refractive index mapping



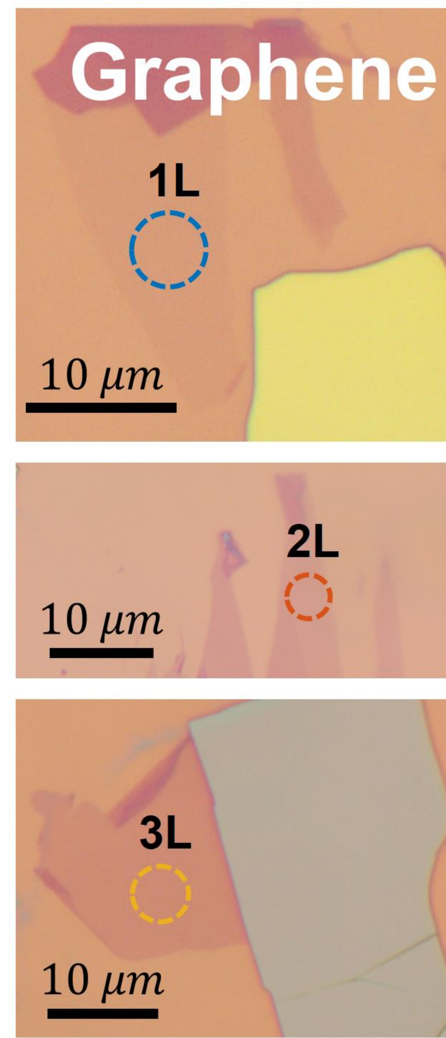

### Complex refractive index of exfoliated $MoS_2$ monolayer

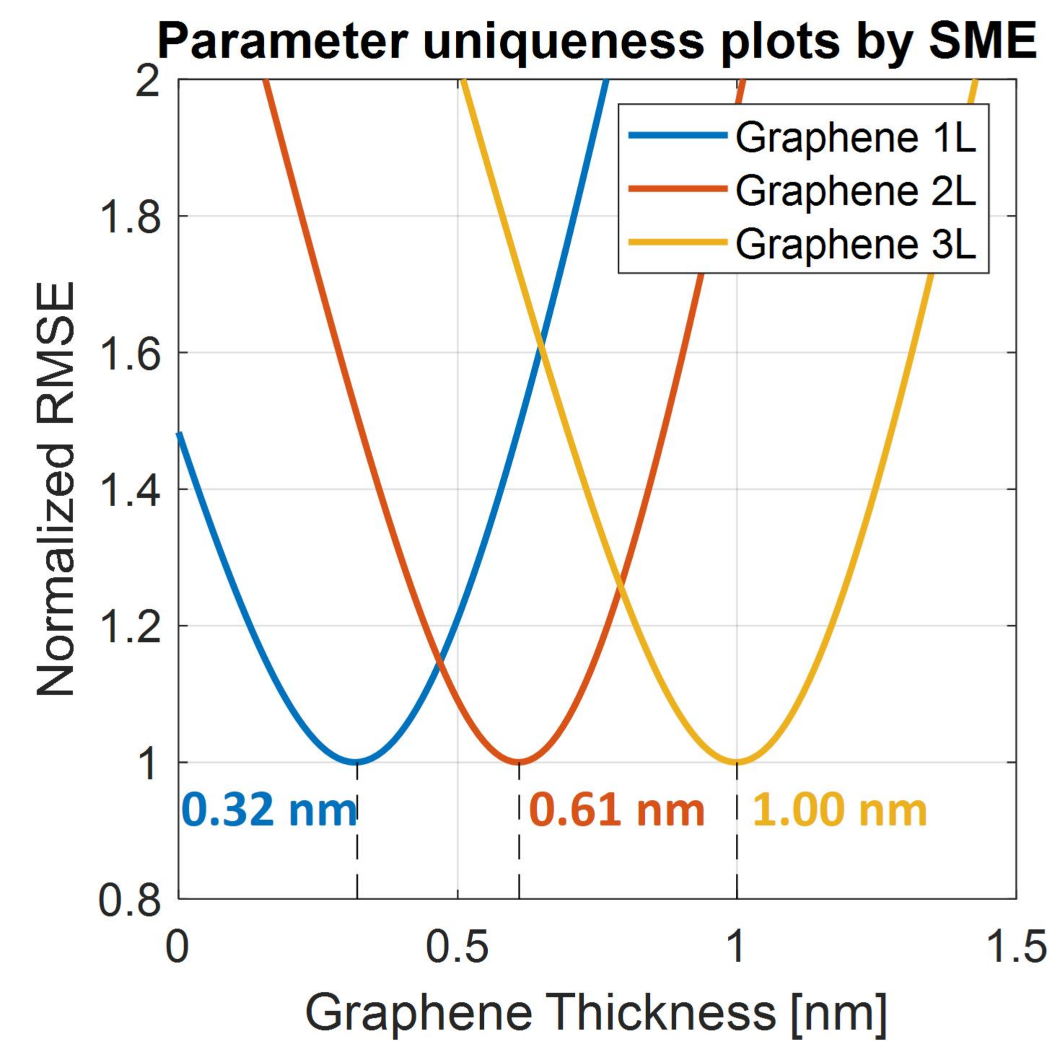



**SME can easily and accurately measure micro-structures**

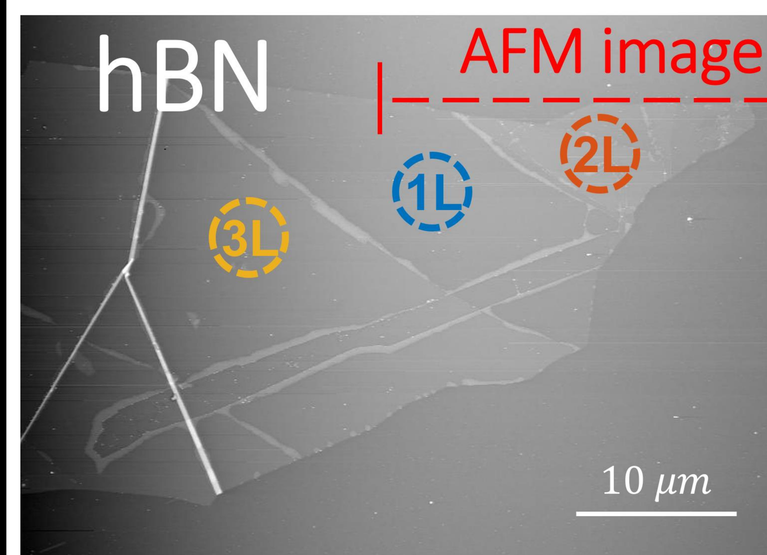
## 3) Thickness of exfoliated vdW materials [3]

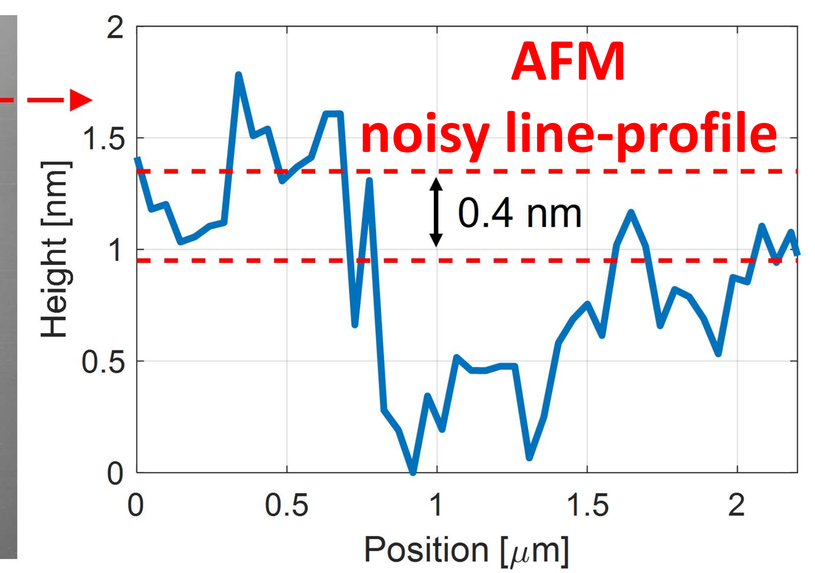
- Parameter uniqueness plot: Error between SME data and model, when the model is scanned for flake's thickness

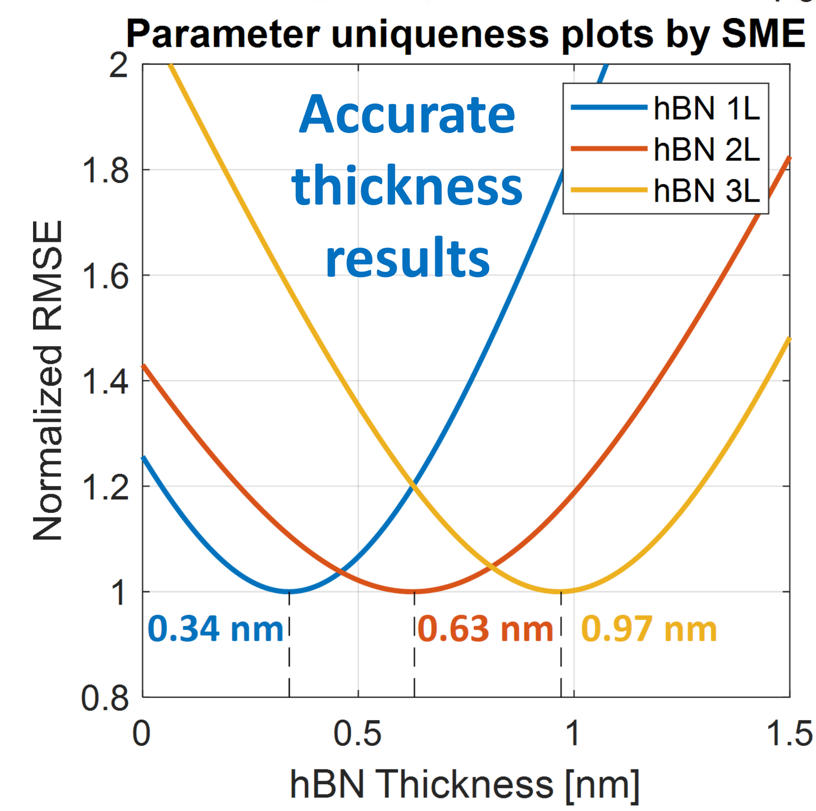


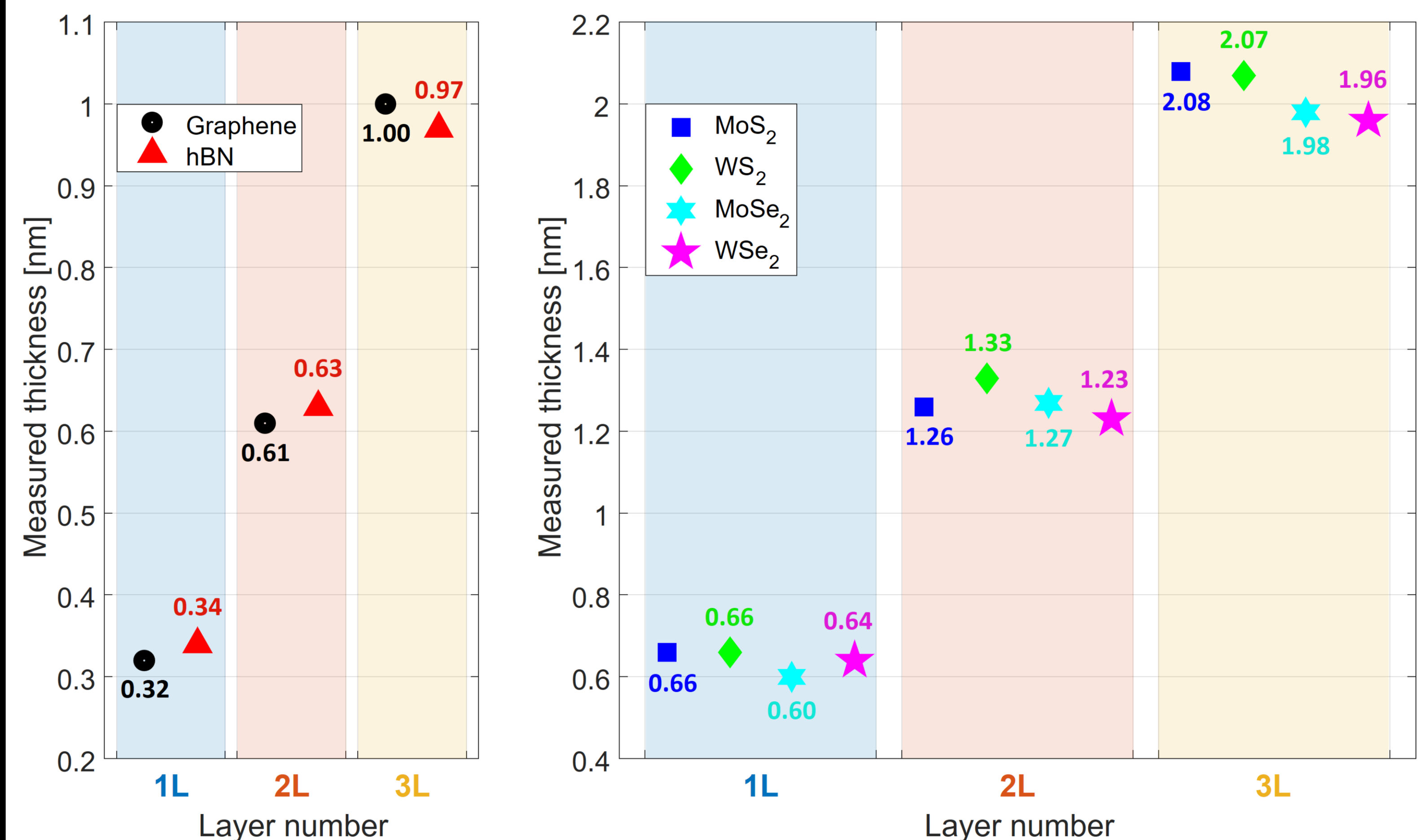

### Thickness of near-transparent hBN flakes by SME



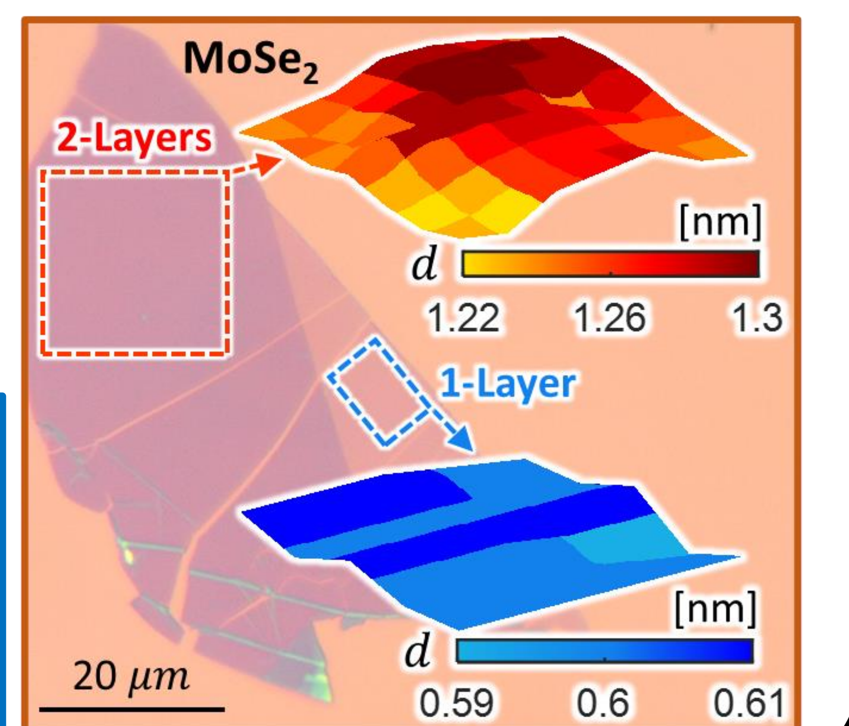




### 1L, 2L, 3L flakes of Graphene, hBN and TMDs




### Thickness mapping on exfoliated $MoSe_2$ flake

SME instrumental accuracy: ± 0.005 nm




**SME can accurately measure & map thicknesses of thin exfoliated 2D-materials**

## References


[1] R. Kenaz and R. Rapaport, **United States Patent No. 11,262,293 B2**, 2022.
[2] R. Kenaz and R. Rapaport, **arXiv:2207.14161**, 2022.
[3] R. Kenaz et al., **arXiv:2211.07437**, 2022.



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