Contribution ID: **151** Type: **Oral presentation**

Direct-ARPES and STM Investigation of FeSe Thin Film Growth by Nd:YAG Laser

Wednesday, 14 September 2022 16:15 (15 minutes)

Research on ultrathin quantum materials requires full control of the growth and surface quality of the specimens in order to perform experiments on their atomic structure and electron states leading to ultimate analysis of their intrinsic properties [1-2]. We report results on epitaxial FeSe thin films grown by pulsed laser deposition (PLD) on CaF2 (001) substrates as obtained by exploiting the advantages of an all-in-situ ultra-high vacuum (UHV) laboratory allowing for direct high-resolution surface analysis by scanning tunneling microscopy (STM), synchrotron radiation X-ray photoelectron spectroscopy (XPS) and angle-resolved photoemission spectroscopy (ARPES) on fresh surfaces. FeSe films are optimized via PLD growth protocols and were fine-tuned by optimizing target-to-substrate distance d and ablation frequency, atomically flat terraces with unit-cell step heights are obtained, overcoming the spiral morphology often observed by others. In-situ ARPES with linearly polarized horizontal and vertical radiation shows hole-like and electron-like pockets at the Gamma and M points of the Fermi surface, consistent with previous observations on cleaved single crystal surfaces. The control achieved in growing quantum materials with volatile elements such as Se by in-situ PLD makes it possible to address the fine analysis of the surfaces by in-situ ARPES and XPS. The study opens wide avenues for the PLD based heterostructures as work-bench for the understanding of proximity-driven effects and for the development of prospective devices based on combinations of quantum materials.

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Session Classification: MS

Track Classification: Interplay between Crystal Growth and Advanced Characterizations for Materials Development