***Advanced hybrid positioning system of SEM and AFM for 2D material surface metrology***

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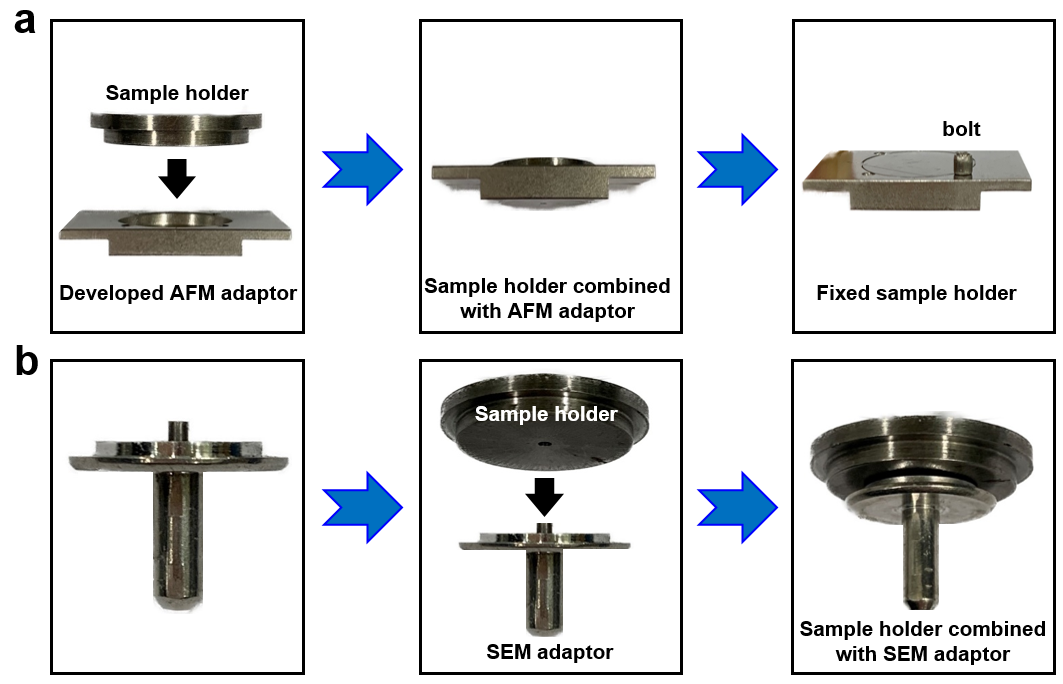
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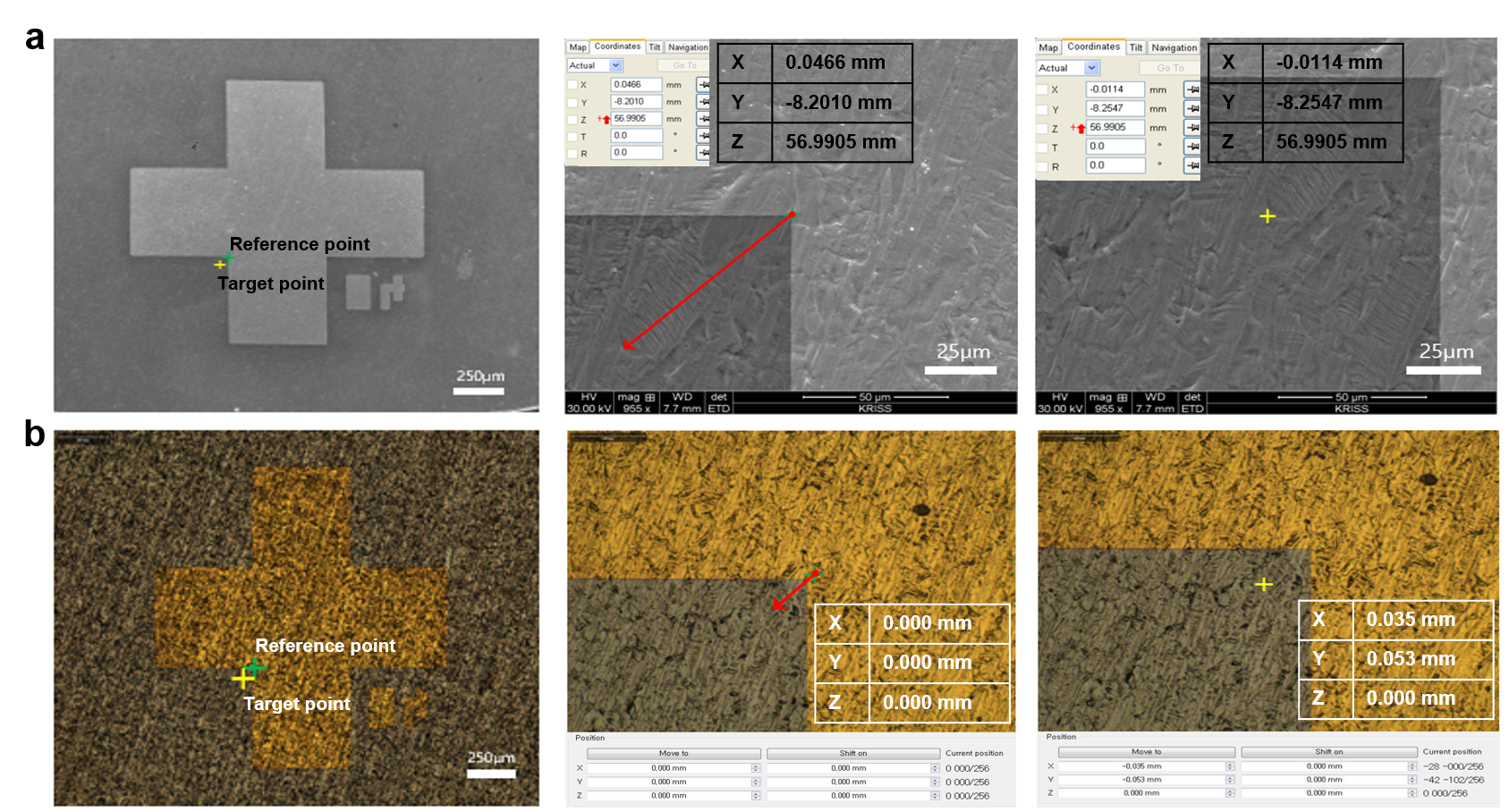
‡These authors contributed equally to this work

**1. SEM and AFM adaptors for measuring the same location using the external hybrid positioning system**



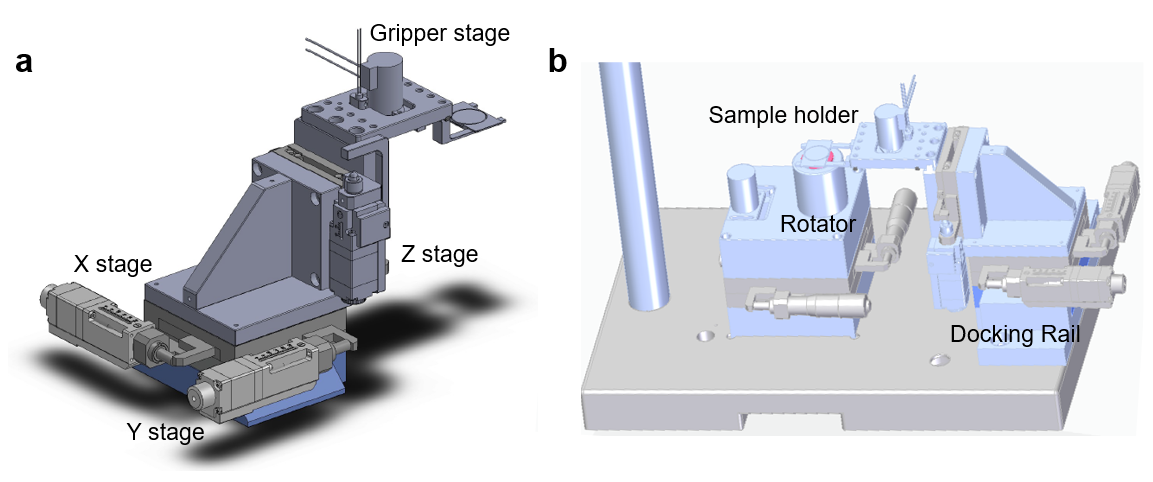
**Fig S1.** (a) Sample holder attached to a developed AFM adaptor, which has the marginal space at the sides for the lift-bar gripper. (b) Sample holder attached to a commercial SEM adaptor.

**2. Alignment mark on the sample holder for measuring the same location between SEM and AFM**



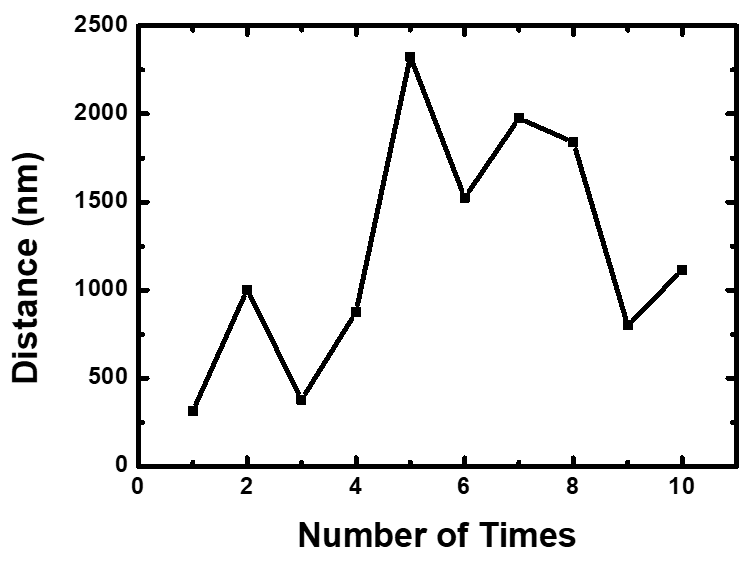
**Fig S2.** Reference point (green cross-shaped mark) on the sample holder for the same measurement coordinate. (a) SEM image of the target point from the reference point (X : 0.047(Reference) - 0.012(Target) = 0.035 mm, Y : -8.201 + 8.255 = 0.054 mm) (b) Optical image of the target point from the reference point using a 5 axis positioning stage for the AFM measurement (X : 0.000(Reference) + 0.035(Target) = 0.035 mm, Y : 0.000 + 0.053 = 0.053 mm)

**3. Schematic of a 5-axis positioning stage with a lift-bar gripper**



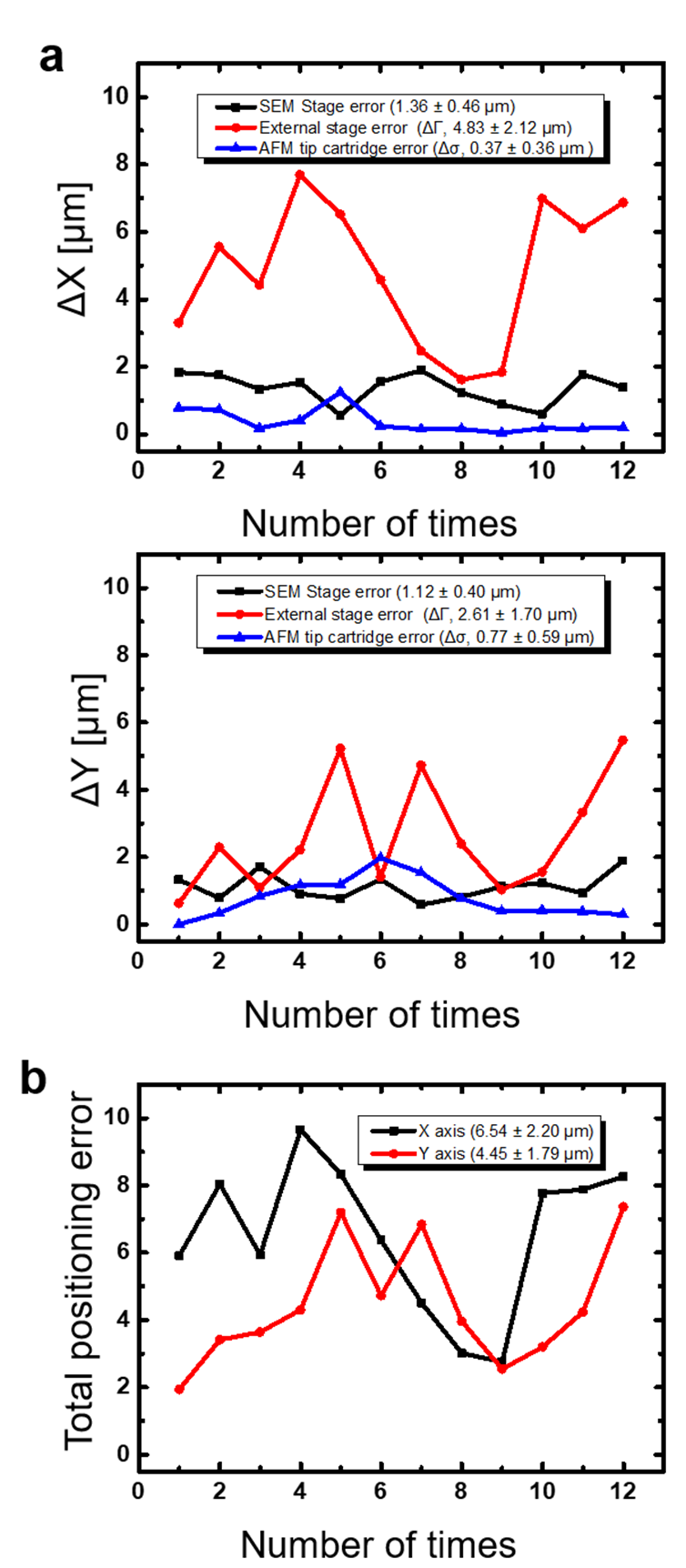
**Fig S3.** Schematic of (a) 4- axis positioning stage (X, Y, Z and Lift-bar gripper stage) and (b) 5–axis positioning stage (Rotator, 4-axis stage mounted on a docking rail).

**4. Spatial offset of the denting points from the coordinate origin**



**Fig S4.** The distance from the origin coordinate to the denting points during the repeated mounting and unmounting process of the tip cartridge.

**5. Analysis of sources of positioning errors between SEM and AFM measurement**

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**Fig S5.** (a) The positioning errors (X and Y axis) between SEM and AFM measurement at the same location (b) Total error (SEM stage error, External stage error, and Tip cartridge error) from the target position in the measurement of X and Y axis.

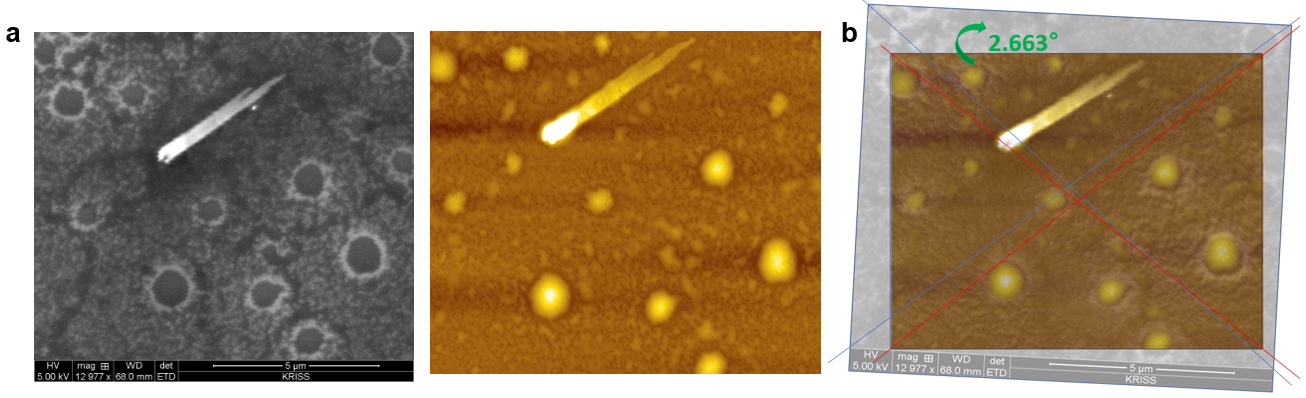
**6. SEM imaging before AFM measurement**

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**Fig S6**. (a) SEM image of Te crystallites rods grown on MoTe2 with a 32 µm FOV. AFM images were contained in an overall SEM image at the same location with a 10-µm FOV.

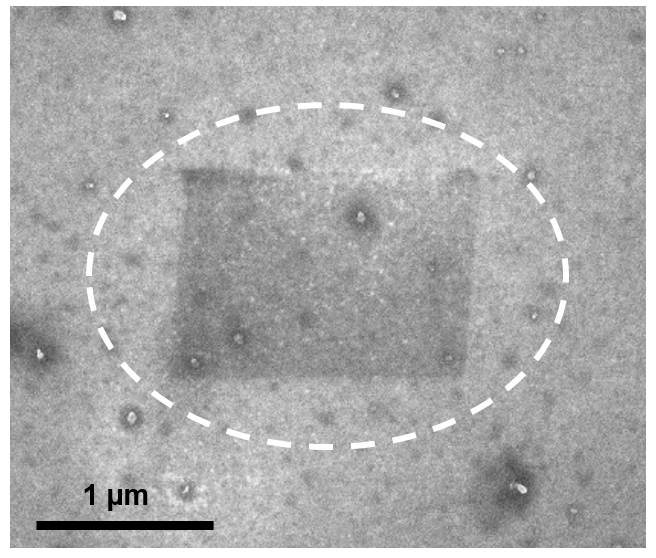
(The upper part of an overall SEM image was analyzed by AFM and the reliability value is indicated in yellow.) (b) Three-dimensional image of the MoTe2 nanorod by AFM measurement (c) Three-dimensional overlay of the SEM and AFM images of MoTe2 nanorod acquire at the same location.

**7. The rotation error between the SEM and AFM image**



**Fig S7.** (a) SEM(left) and AFM(right) images at the same location using a developed rotator. (b) Overlay of SEM and AFM images, the error of rotational accuracy is estimated to be 2.663**°**.

**8. Beam damage on a 1layer MoS2 film occurred during the SEM measurement**



**Fig S8.** SEM image of a monolayer MoS2 film. A burn mark appeared during an electron beam.

**9. AFM measurement before SEM imaging**



**Fig S9.** (a) AFM and (b) SEM image of MoS2 film at the same location, respectively. (The roughness was 1.36 nm and the reliability value is indicated in yellow.) (c) Three-dimensional image of MoS2 grains measured by AFM (c) Three-dimensional overlay of SEM and AFM images of MoS2 grains at the same location.