Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information

IR Position-Sensitive Detectors Based on the Double-Junction Asymmetric TiO_2/MoS_2/Reduced Graphene-Oxide Sandwiches

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Keywords: MoS_2/reduced graphene oxide; Lateral photovoltage effect; optical position sensors; 2D infrared photodetectors

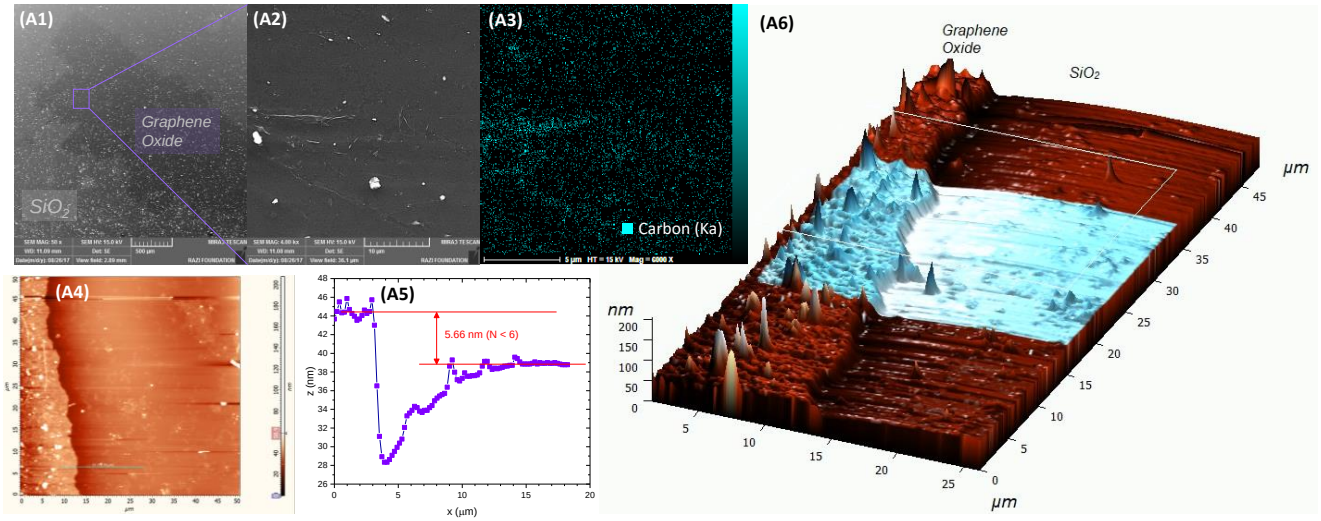


Figure S1. (A1-A2) SEM images of a large-area graphene oxide sheet used as substrate for the MoS_2 growth. (A3) EDS elemental surface map showing the distribution of carbon atoms in A2. (A4) AFM topographic image obtained from the edge of graphene oxide sheet. (A5) The thickness profile of the indicated line in A4. The average thickness of graphene oxide sheet obtained from different parts of the edge is esimated to be ~ 6 nm suggesting the average number of graphene layers to be N < 10. (A6) 3D topographic image from the edge of graphene oxide sheet in A4 illustrating the puckered surface of RGO. The ice colord region is devoted for better identification of crossing between SiO_2 and graphene oxide sheet.

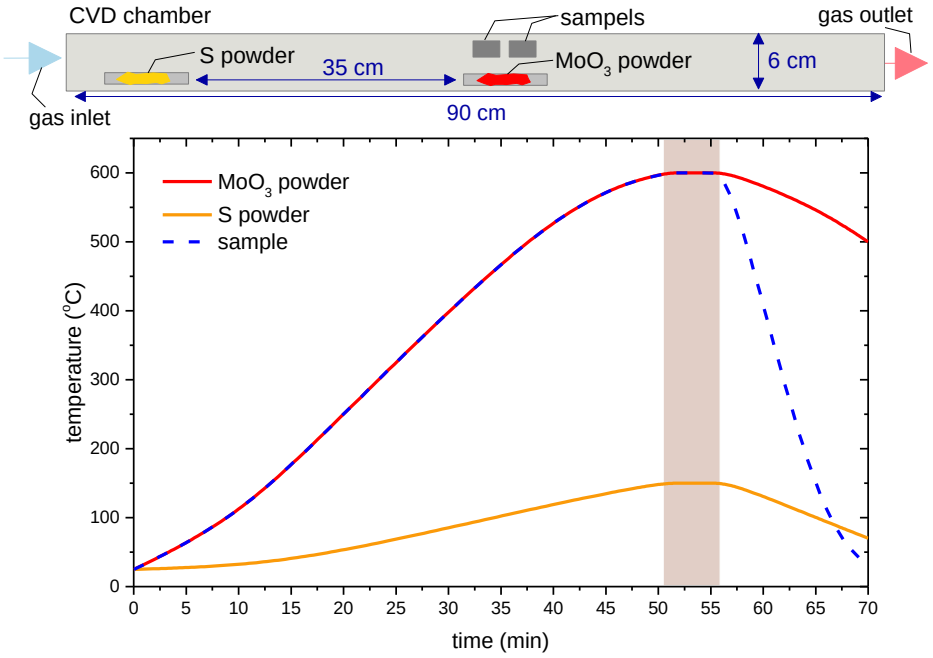


Figure S2. Upper panel: The schematic of CVD configuration used for the growth of MoS_2 falkes. Down panel: The temperature–time diagram of the MoO_3 powder, S powder, and test samples during the growth MoS_2 nanoflakes.

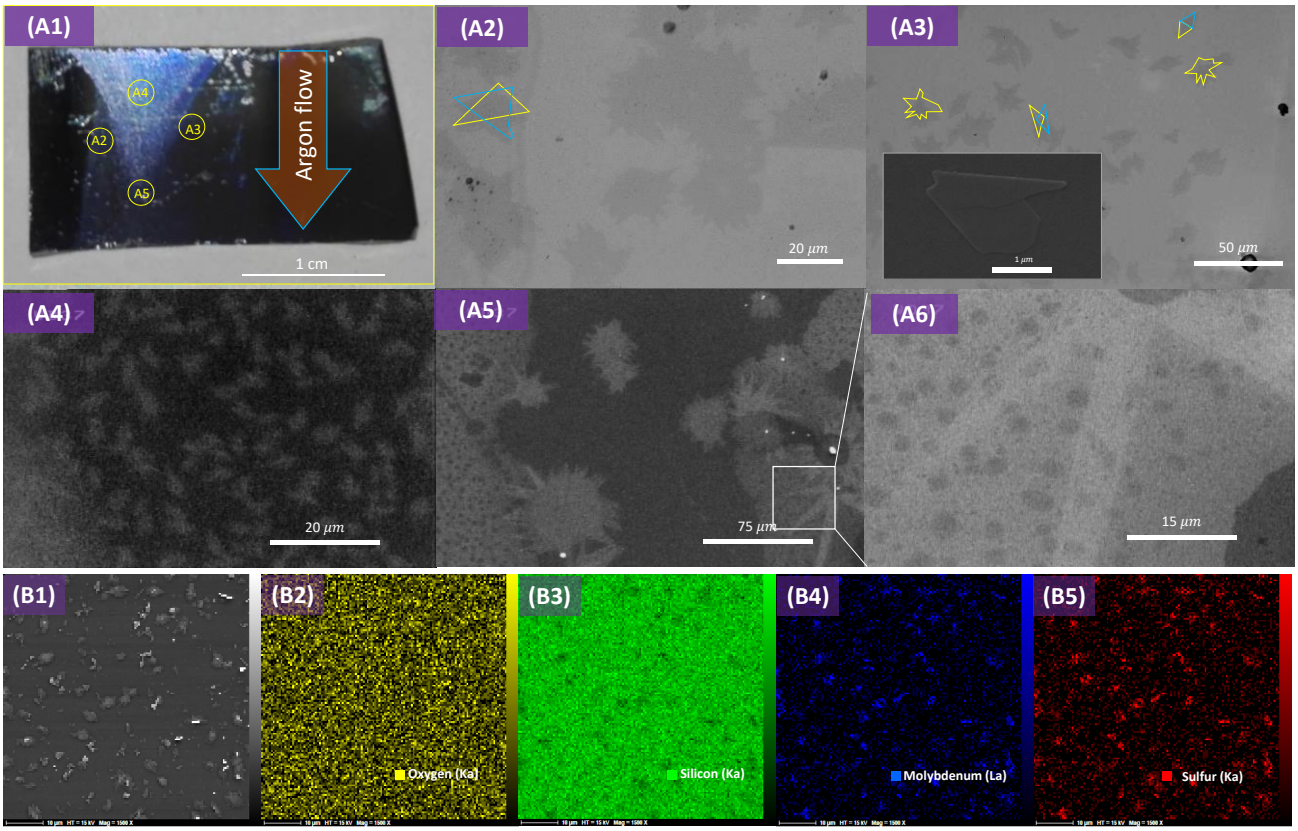
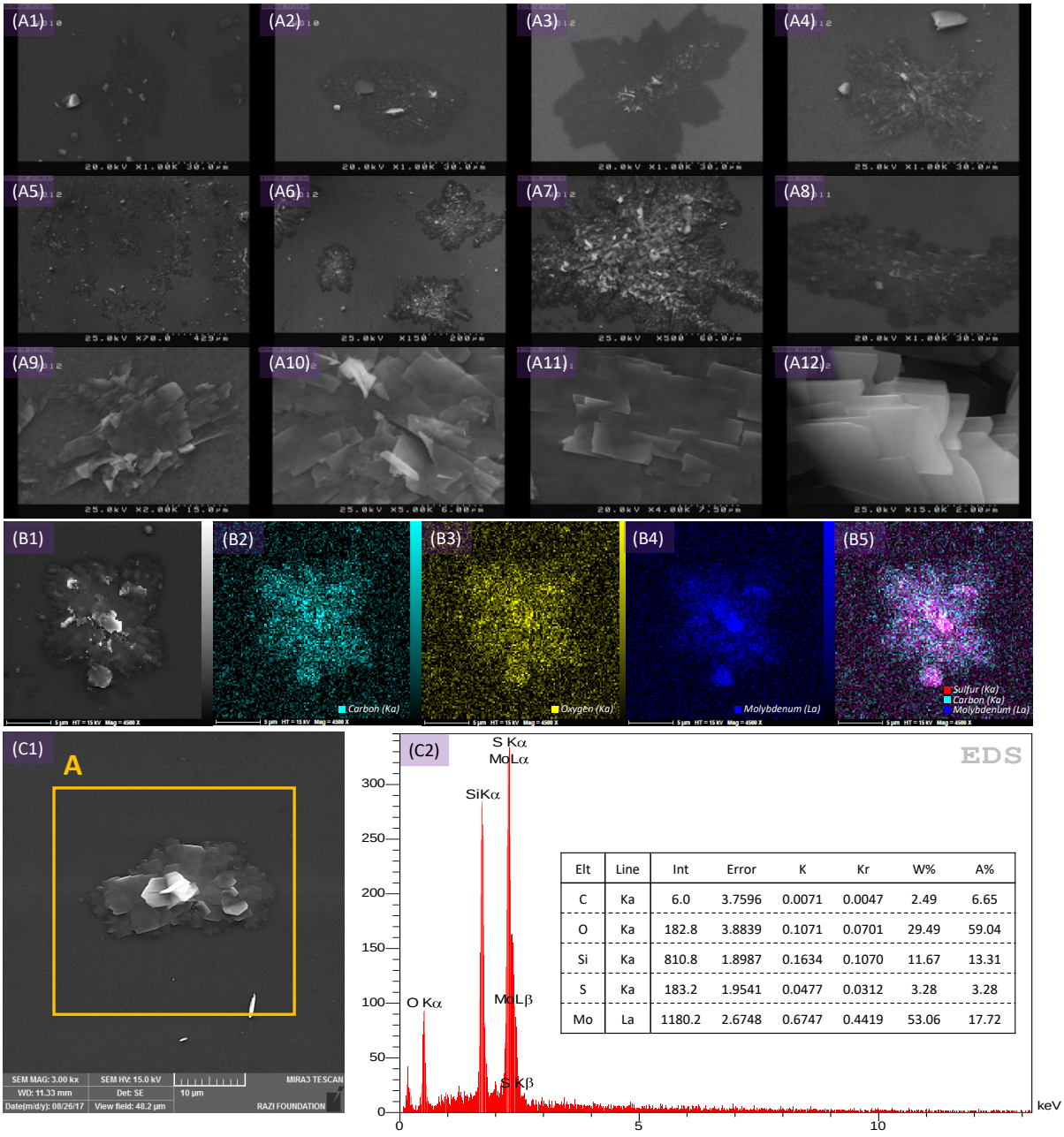


Figure S3. (A1) Optical image of a SiO_2 sample covered by MoS_2 mono/few-layers. Direction of the gas flow is depitected in the photo. (A2-A5) SEM images obtained from different parts of the sample. The corresponding location of each image is indicated in A1. The well-known MoS_2 triangle crystalls with mono/bi-layer structure are appeared in the side regions (A2 and A3). The central region of the sample is covered via multilayer MoS_2 flakes as shown in A4 and A5. (A6) shows a magnified image from the indicated part in A5. (B1-B5) EDS elemental surface map obtained from the central region of the sample showing the distribution of oxygen, silicon, molybdenium, and sulfur. It is noted that the oxygen atoms are distributed uniformly over the surface of SiO_2 and no concentration of the oxygen is observed in those regions covered by flakes which implies the absence of MoO_x on the SiO_2 surface.



Elt	Line	Int	Error	K	Kr	W%	A%
C	Ka	6.0	3.7596	0.0071	0.0047	2.49	6.65
O	Ka	182.8	3.8839	0.1071	0.0701	29.49	59.04
Si	Ka	810.8	1.8987	0.1634	0.1070	11.67	13.31
S	Ka	183.2	1.9541	0.0477	0.0312	3.28	3.28
Mo	La	1180.2	2.6748	0.6747	0.4419	53.06	17.72

Figure S4. (A1-A4) The evolution of fractal structures during the growth process. (A5-A8) SEM images from the fractal-like aggrigations of MoS_2 flakes in different samples. (A9-A12) Magnified SEM images taken from the top of different fractals indicating the multilayered structure of stacked MoS_2 flakes. (B1-B5) EDS elemental distribution surface maps taken from a fractal-like aggrigation of MoS_2 nanoflakes. (C1-C2) EDS analysis of the relative wieght and area coverage (in percent) of different elements measured through the frame A in C1.

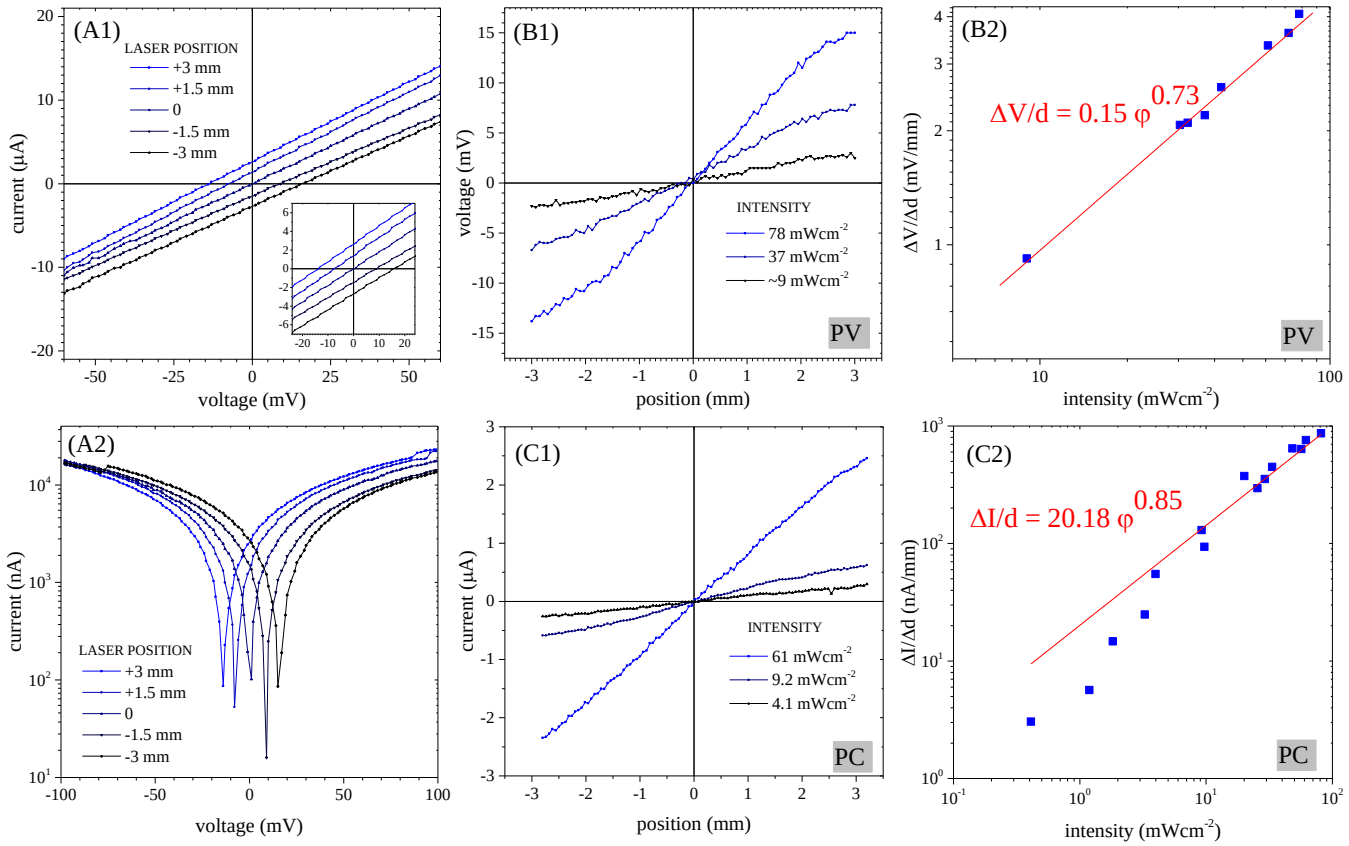


Figure S5. PSD response charactersitics upon blue laser illumination ($\lambda = 405\,nm$). (A1 and A2) Current-voltage charactersitics under localized blue illumination (spot size ≈ 300 μm). (B1 and C1) Photovoltage-position and photocurrent-position in photovoltage and photocurrent operational modes. (B2 and C2) The dependence of PSD sensitivity on the incident light intensity in PV and PC modes.

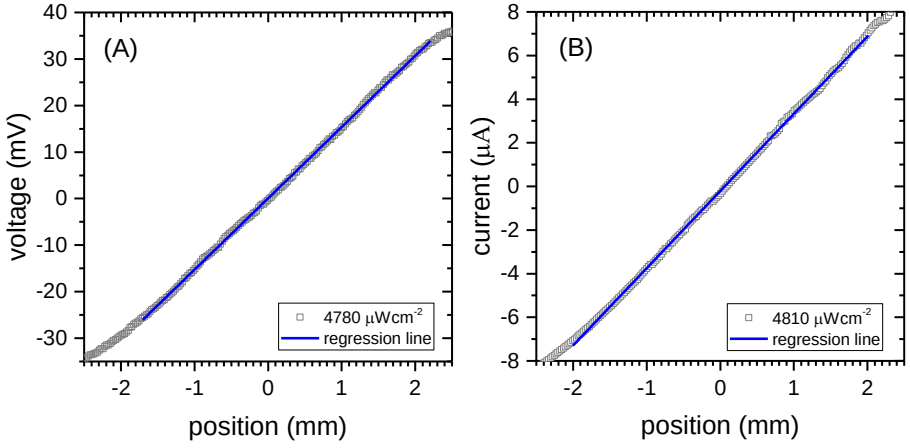


Figure S6. Linear response of the PSD and the corresponding regression line in (A) PV and (B) PD operational modes. The position of IR sopt is changed with 25 μm increments.

Table S1. The details of SAED pattern analaysis showen in Figure 1(C4) of the main manuscript

CrysTBox diffractGUI - analysis report

File: 19.jpeg

Zone axis: 2 3 2

Material: Mo S2

Estimate Rating Very good

Source file: Crystallography Open Database (COD)
Information card for entry 9007660 (http://www.crystallography.net/cod/9007660.html)
Mineral name: Molybdenite Formula: Mo S2 Calculated formula: Mo2 S4 Revision: 188410 Date: 2016-11-13
http://www.crystallography.net/cod/9007660.cif@188410

Lattice vectors:

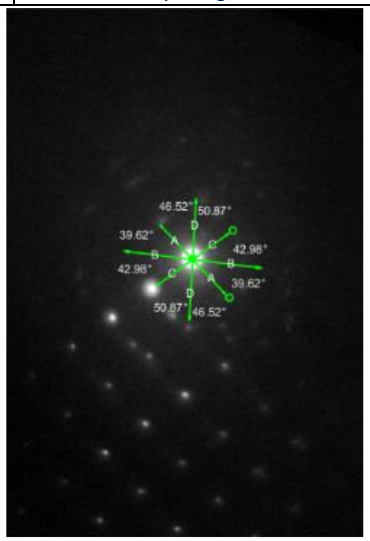
Lattice vectors are quantified. Vector lengths in direct and reciprocal space, their ratios and angular distances are enumerated.

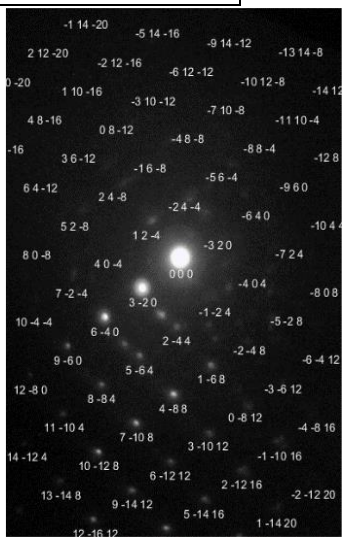
	d-spacing			d-spacing (Cal.coef.=11.85)			d-spacing ratios [-]			
	[nm]	[1/nm]		[nm]	[1/nm]		A	B	C	D
A	0.0082013	121.9319	A	0.097185	10.2896	A	1	1.4548	0.93545	1.2782
B	0.0056374	177.3869	B	0.066803	14.9694	B	0.68738	1	0.64301	0.87858
C	0.0087672	114.0612	C	0.10389	9.6254	C	1.069	1.5552	1	1.3664
D	0.0064165	155.8478	D	0.076036	13.1517	D	0.78238	1.1382	0.73188	1

Zone axis estimate:

Individual lattice vectors are crystallographically identified and the zone axis is calculated.

vector identification		Zone axis:	2 3 2
		Estimation rating:	Very good
A	-1 -2 4	Consistency check:	OK
B	-4 0 4	Lattice check:	OK
C	-3 2 0	Total angular distance:	1.40
D	-2 4 -4	D-spacing STDEV:	0.0005





This report is generated using software CrysTBox diffractGUI 2.21 by Miloslav Klinger.

Ref: M. Klinger. More features, more tools, more CrysTBox. Journal of Applied Crystallography, 50, 2017. doi:10.1107/S1600576717006793

Table S2. The details of SAED pattern analaysis showen in Figure 1(C5) of the main manuscript

CrysTBox diffractGUI - analysis report

File: 21.jpeg

Zone axis: -3 -3 1

Material: Mo O3

Estimate Rating Excellent

Source file:

American Mineralogist Crystal Structure Database (AMCSD)
Database code amcsd: 0018894 Mineral name: Molybdite Formula: Mo O3 Date: 2009
Ref: Sitepu H, Powder Diffraction 24 (2009) 315-326, Texture and structural refinement using neutron diffraction data from molybdite (MoO3) and calcite (CaCO3) powders and a Ni-rich Ni50.7Ti49.30 alloy
http://rruff.geo.arizona.edu/AMS/minerals/Molybdite
http://rruff.geo.arizona.edu/AMS/download.php?id=19447.cif&down=text

Lattice vectors:

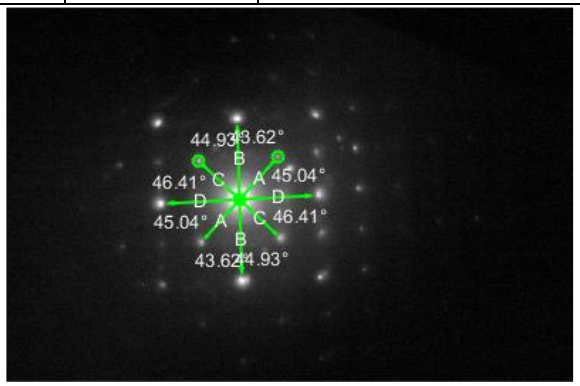
Lattice vectors are quantified. Vector lengths in direct and reciprocal space, their ratios and angular distances are enumerated.

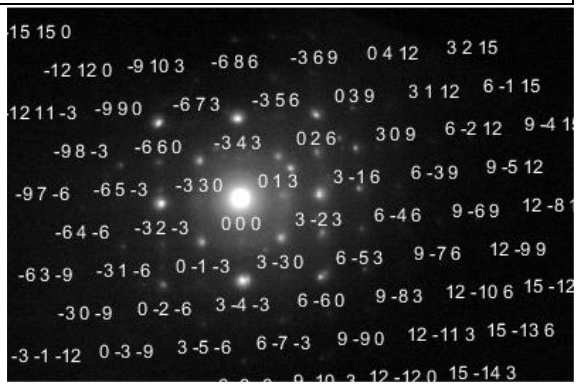
	d-spacing			d-spacing (Cal.coef.=11.85)			d-spacing ratios [-]			
	[nm]	[1/nm]		[nm]	[1/nm]		A	B	C	D
A	0.0063552	157.3515	A	0.12393	8.0693	A	1	1.4157	0.97689	1.38
B	0.0044892	222.7576	B	0.087539	11.4235	B	0.70638	1	0.69006	0.97483
C	0.0065055	153.7152	C	0.12686	7.8828	C	1.0237	1.4492	1	1.4127
D	0.0046051	217.1515	D	0.089799	11.136	D	0.72462	1.0258	0.70787	1

Zone axis estimate:

Individual lattice vectors are crystallographically identified and the zone axis is calculated.

vector identification		Zone axis:	-3 -3 1
		Estimation rating:	Excellent
A	0 1 3	Consistency check:	OK
B	-3 4 3	Lattice check:	OK
C	-3 3 0	Total angular distance:	0.74
D	-3 2 -3	D-spacing STDEV:	0.0005





This report is generated using software CrysTBox diffractGUI 2.21 by Miloslav Klinger.
Ref: M. Klinger. More features, more tools, more CrysTBox. Journal of Applied Crystallography, 50, 2017. doi:10.1107/S1600576717006793