Φ – 575 Διάλεξη 08

Φυσική διατάξεων δισδιάστατων ημιαγωγών

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Doping of 2D materials?

Υπάρχουν δύο προσεγγίσεις:

- Non covalent doping (adsoprtion)
  - Charge transfer
  - Intercalation
- Covalent doping (substitutional)
- Dynamic doping (electrostatic)

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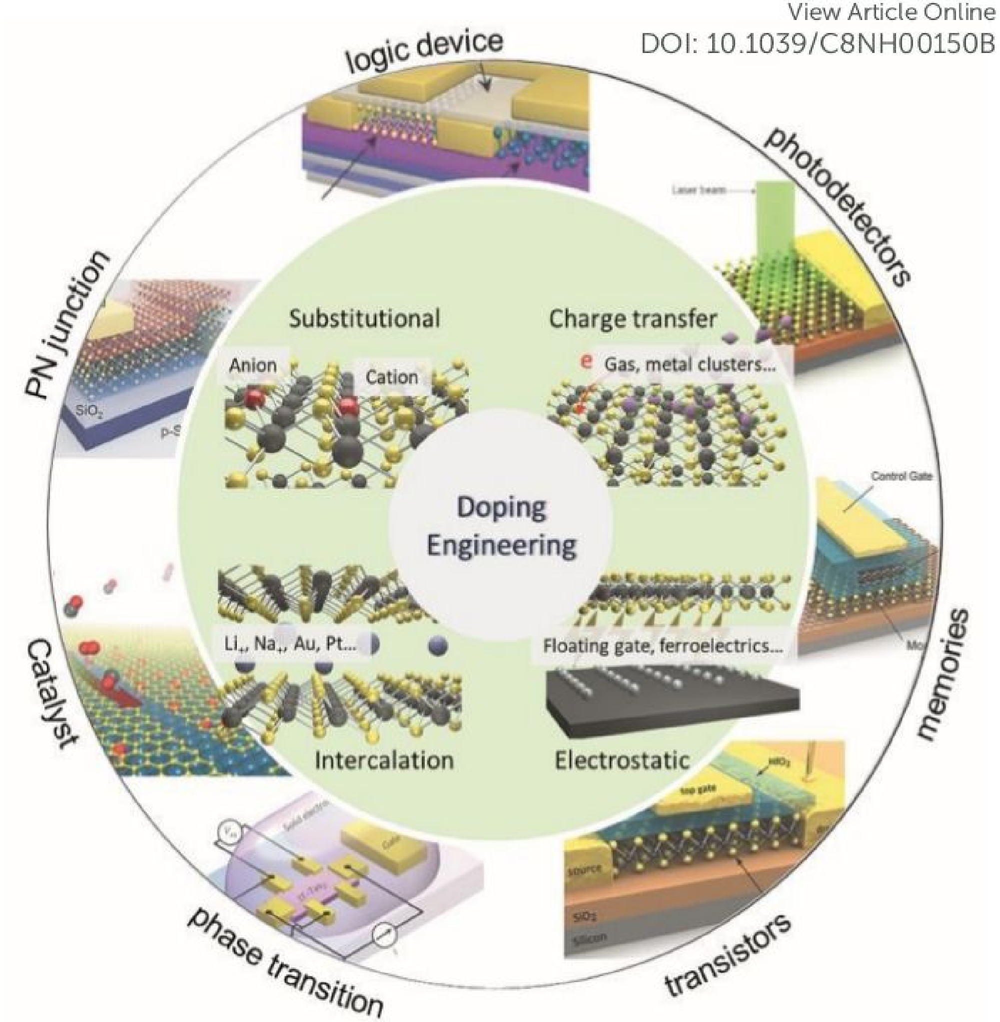

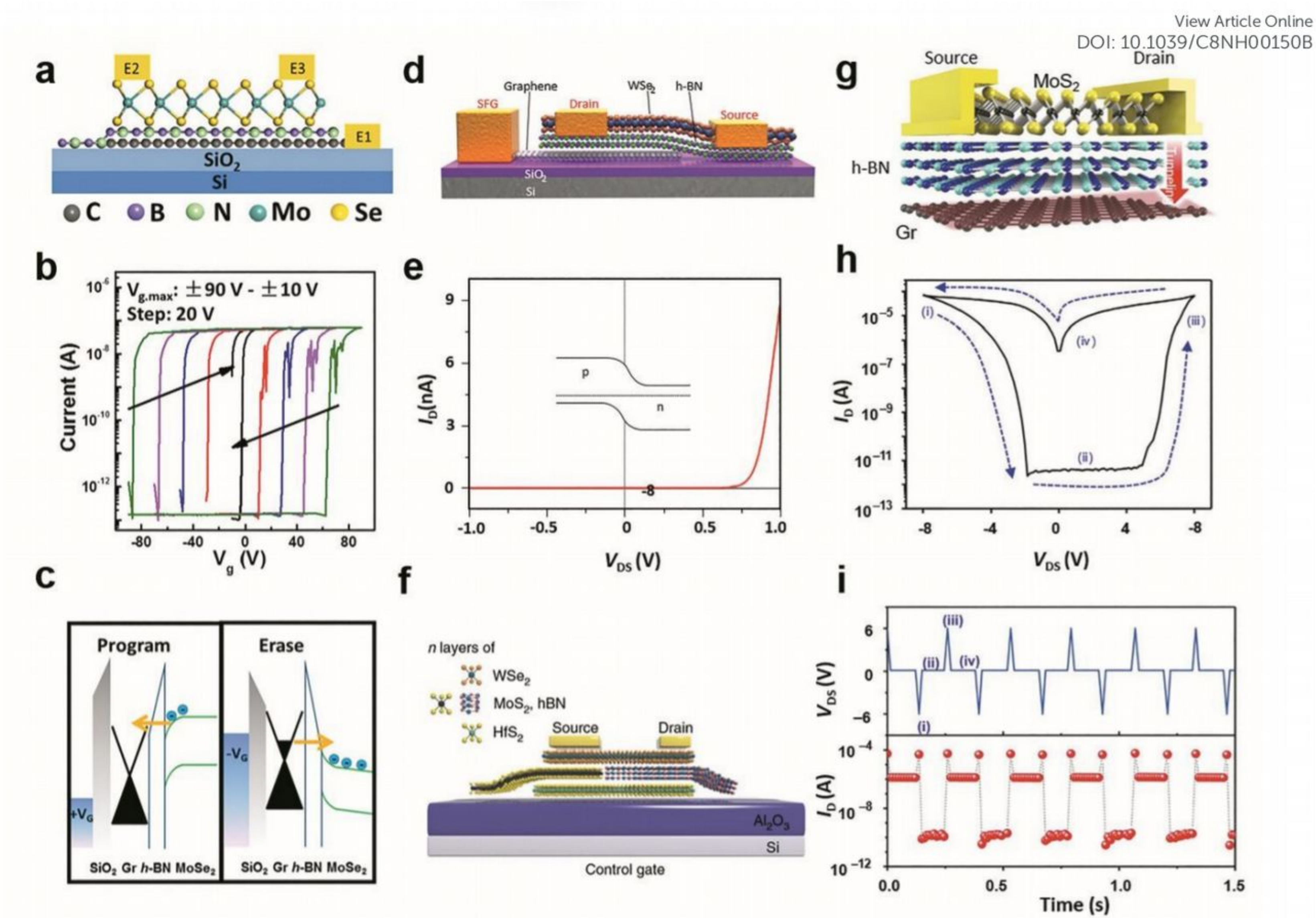
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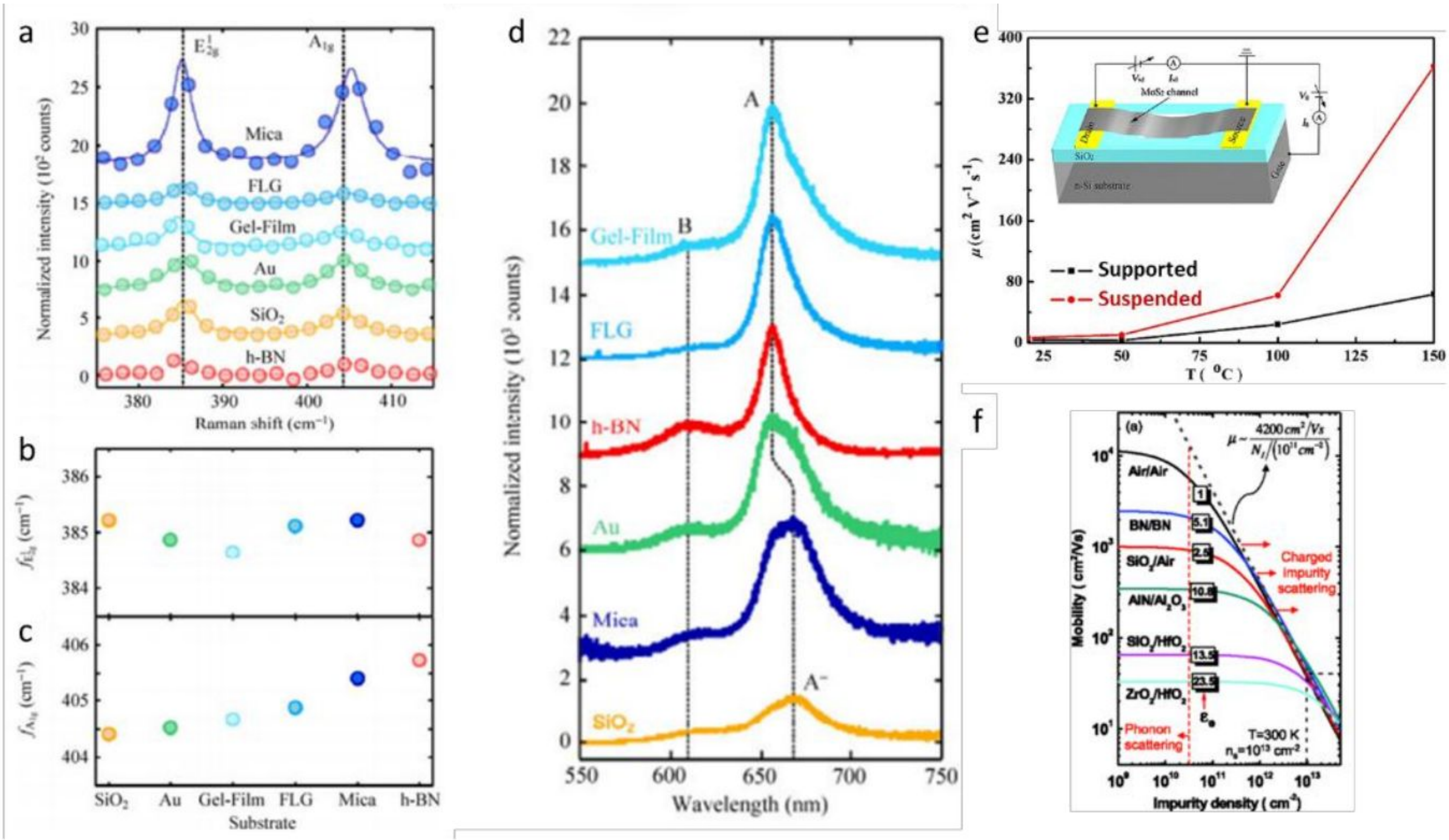
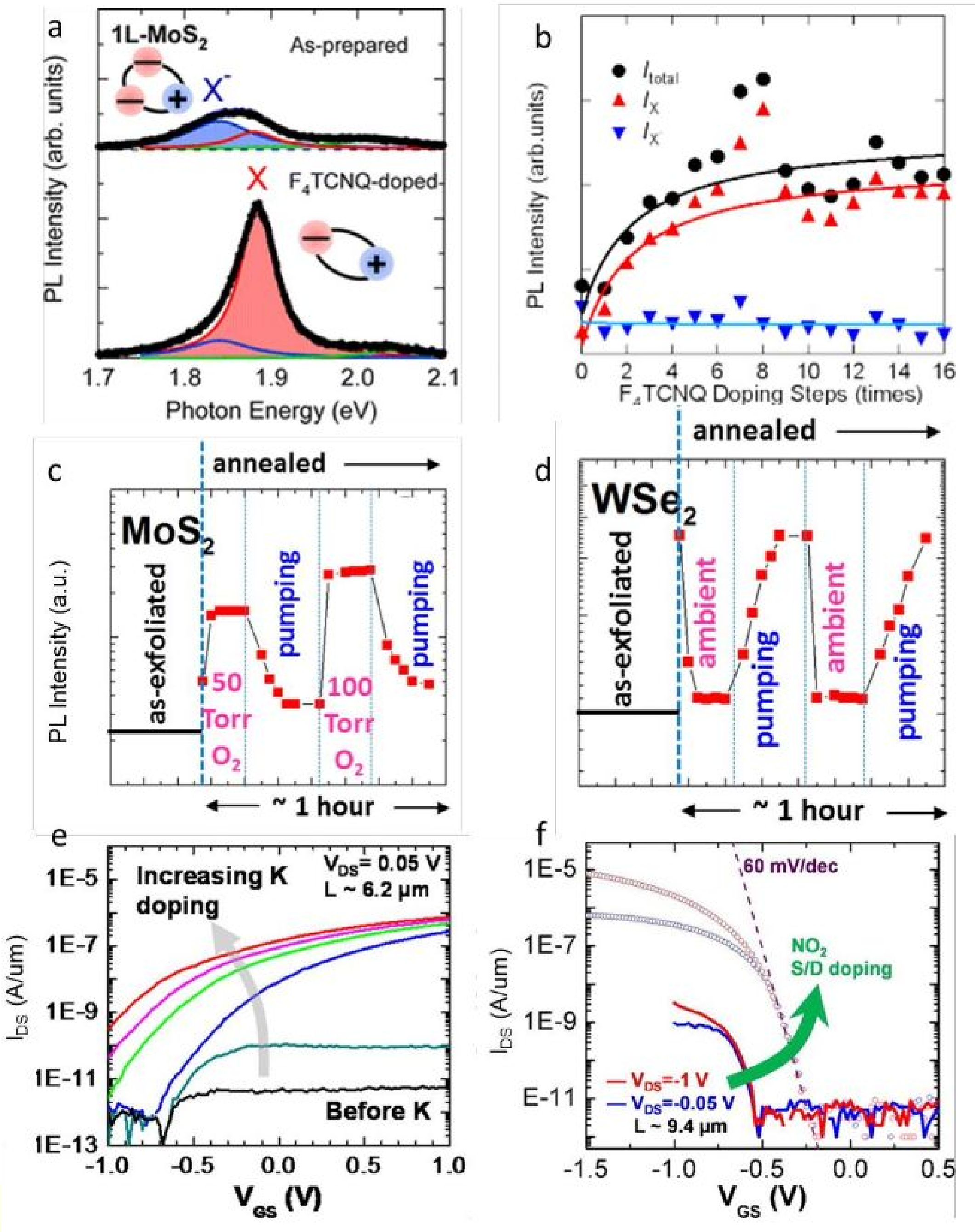
DOI: 10.1039/C8NH00150B
a
E2
E3
E1
SiO2
Si
C B N Mo Se
b
Vg,max: ±90 V - ±10 V
Step: 20 V
Current (A)
Vg (V)
c
Program
Erase
+VG
-VG
SiO2 Gr h-BN MoSe2
d
Graphene
WSe2
h-BN
SFG
Drain
Source
e
ID (nA)
VDS (V)
p
n
f
n layers of
WSe2
MoS2, hBN
HfS2
Source
Drain
Al2O3
Si
Control gate
g
Source
Drain
MoS2
h-BN
Gr
h
ID (A)
VDS (V)
i
VDS (V)
ID (A)
Time (s)

Επίδραση υποβάθρου (substrate)



Επίδραση ατμόσφαιρας



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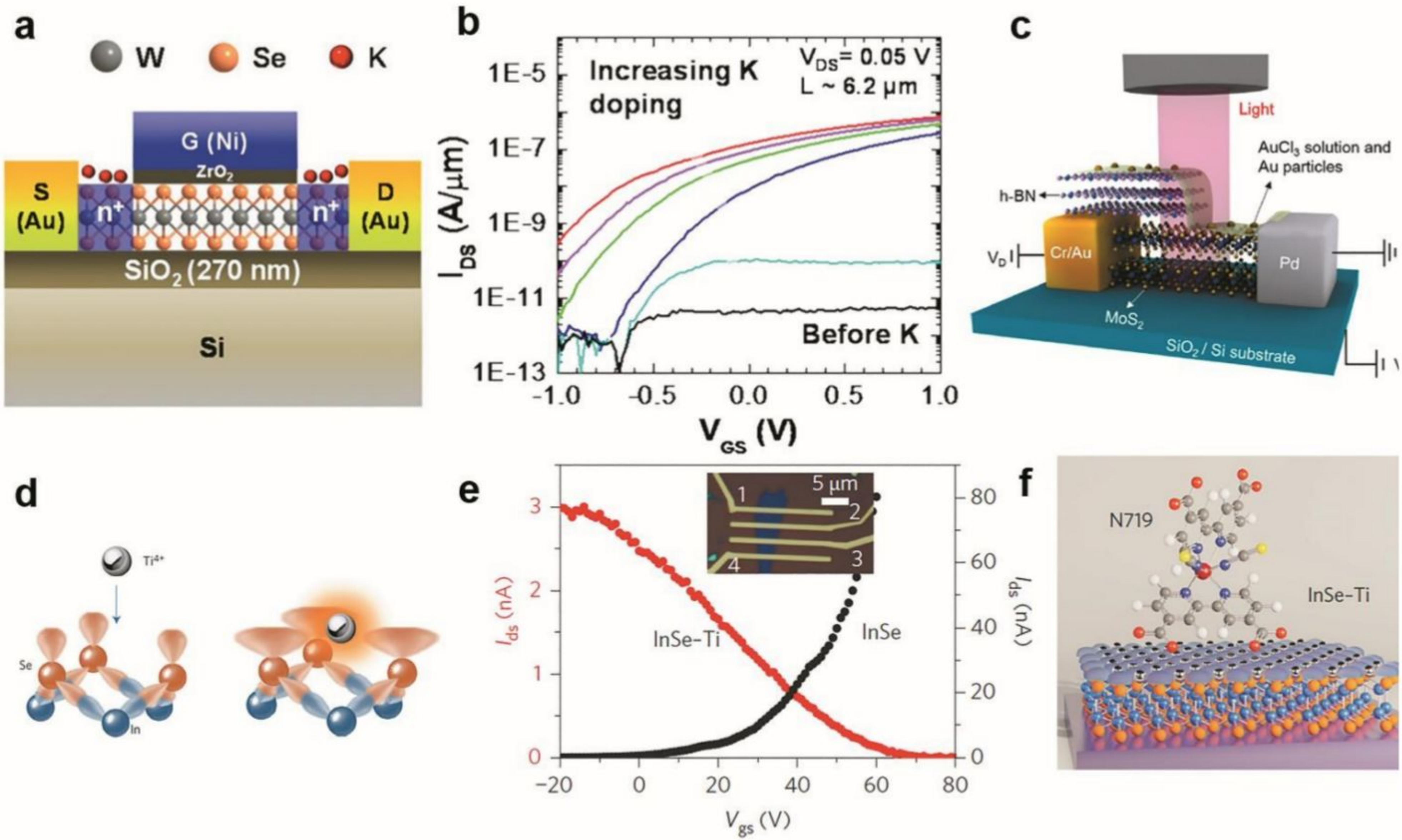
Decorating with foreign atoms



Substituting metal in TMDCs

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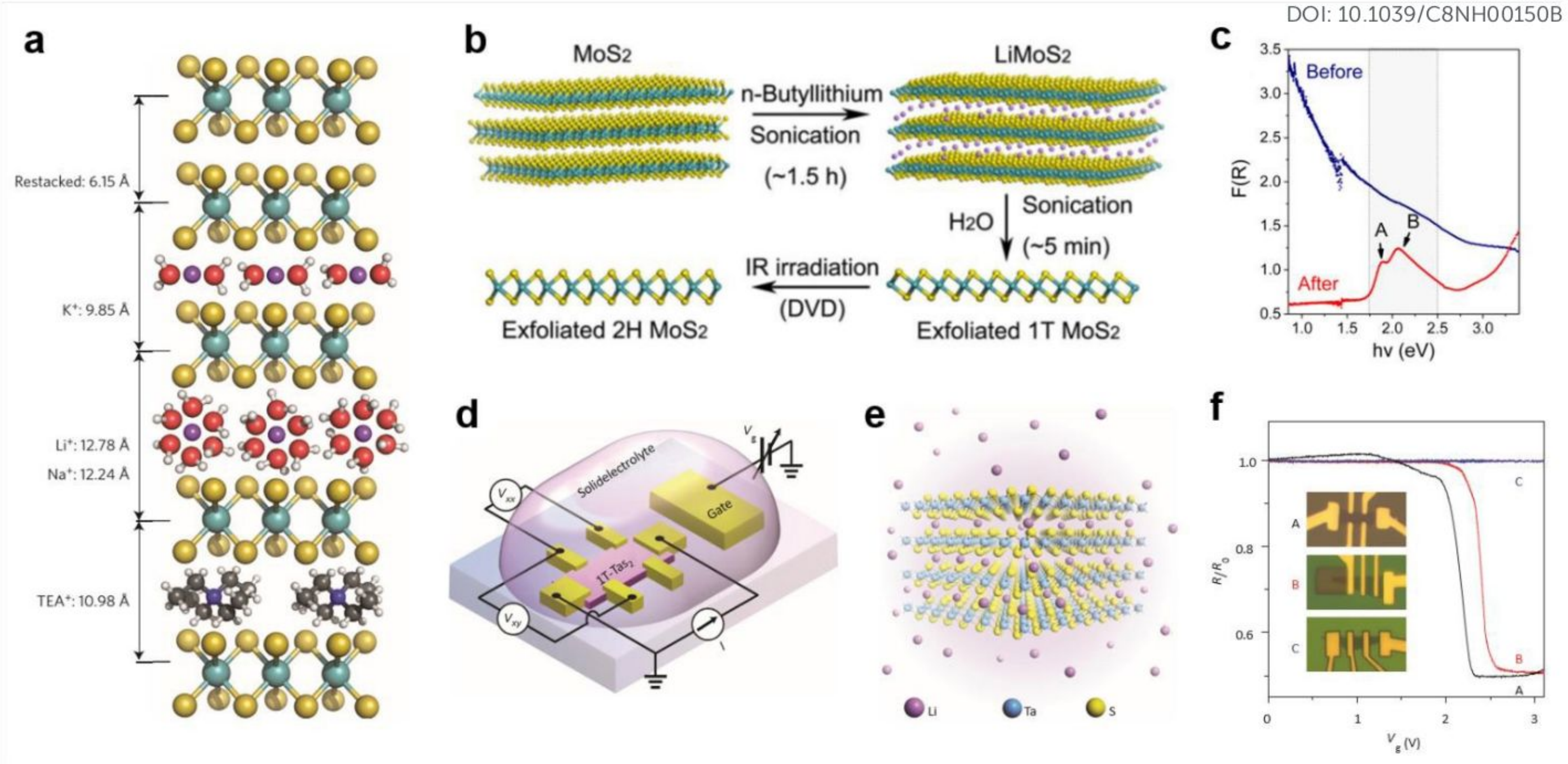

Figure 9. Intercalation modulation to MXs: (a) intercalation of MoS_2 by alkali ions (Li^+, Na^+, K^+) with solvent molecules and the case by TEA^+, reprinted with permission from ref.184, Copyright 2015 Nature Publishing group. (b) Sonication assisted exfoliation of MoS_2 into 1T phase and the IR irradiation assisted restoration, and (c) the resulted reflectance spectra change, reprinted with permission from ref. 191, Copyright 2015 American Chemical Society. (d) Electrochemical setup and (e) the illustration of Li intercalation in TaS_2, (f) patterned control of Li^+ intercalation in to devices and the resulted gate modulation characteristic, reprinted with permission

Substituting the anion

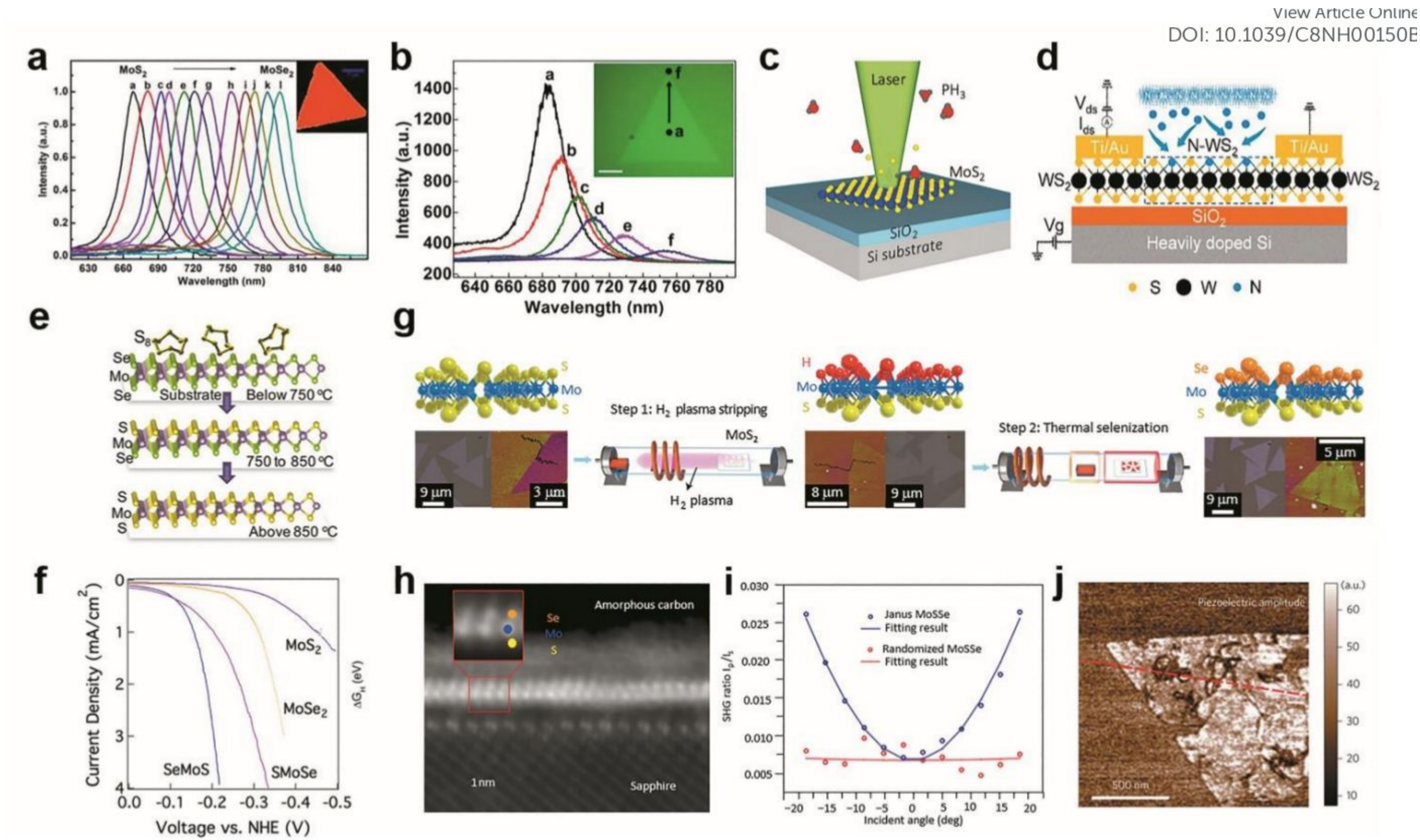

Figure 4. Substitutional doping at anion sites: (a) the PL of composition tuned $MoS_{2x}Se_{2(1-x)}$ with uniform distribution and (b) the one with composition gradient in a single flake, reprinted with permission from ref. 102 and 109, Copyright 2014, 2015 American Chemical Society. (c) Laser assisted selective area doping by PH_3, reprinted with permission from ref. 100, Copyright 2016 American Chemical Society. (d) Schematic of N_2 plasma doping to WS_2, reprinted with permission from ref.

Adding other species

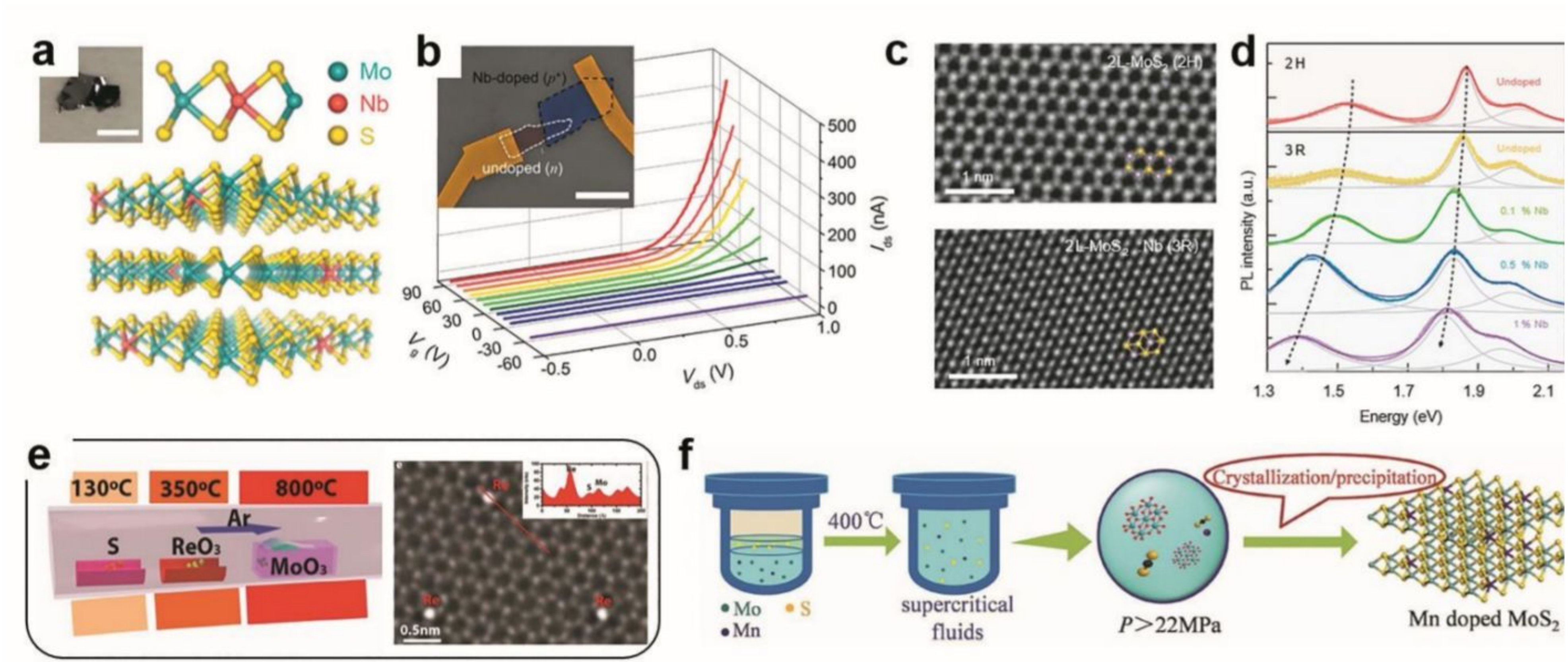

Figure 3. Substitutional doping at cation sites: (a) schematic illustration of substitutional Nb doping in MoS_2 in partial replacement of Mo atoms, (b) the resulted rectification behaviour in a gate modulated junction formed between Nb-doped and undoped MoS_2, reprinted with permission from ref. 25, Copyright 2014 American Chemical Society. (c) high resolution TEM image of bilayer MoS_2 in 2H and 3R phase induced by Nb doping, and (d) their PL characteristics, reprinted with permission from ref. 40, Copyright 2018 Nature Publishing group. (e) A typical CVD configuration for in-situ doping during growth using multiple source evaporation and the TEM image of resulted Re doped MoS_2, reprinted with permission from ref. 71, Copyright 2018, Wiley-VCH. (f) Illustration of hydrothermal procedures to achieving Mn doped MoS_2 in supercritical conditions, reprinted with permission from ref. 99, Copyright 2017, Wiley-VCH.

Σχετική βιβλιογραφία

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