Supporting Information

Liquid-Phase Intermediated Chemical Vapor Deposition for Ternary Compositional 1D van der Waals Material Nb₂Pd₃Se₈

Sang Hoon Lee^{a,†}, Byung Joo Jeong^{a,†}, Kyung Hwan Choi^b, Jiho Jeon^b Bom Lee^a, Sooheon Cho^a, Dahoon Kim^a, Gutema Teshome Gudena^c, Daba Deme Megersa^c, Sang Hyuk Kim^{a,*}, Hak Ki Yu^{c,*}, and Jae-Young Choi^{a,b,d,*}

^a School of Advanced Materials Science & Engineering, Sungkyunkwan University, Suwon

16419, Republic of Korea.

^b SKKU Advanced Institute of Nanotechnology (SAINT), Sungkyunkwan University, Suwon

16419, Republic of Korea.

^c Department of Materials Science and Engineering & Department of Energy Systems Research,

Ajou University, Suwon 16499, Republic of Korea.

^d KIST-SKKU Carbon-Neutral Research Center, Sungkyunkwan University, Suwon 16419,

Republic of Korea

Table of contents of supplementary information

- Fig. S1 Schematic diagram of the Nb₂Pd₃Se₈ nanowire growth using the LPI-CVD process
- Fig. S2 Morphology of precursor coated substrate.
- Fig. S3 Cross section-SEM images of Nb₂Pd₃Se₈ nanowires grown on the substrate.
- Fig. S4 XRD patterns after the LPI-CVD process at 560, 580, 600, and 620 °C
- Fig. S5 SEM images of Nb₂Pd₃Se₈ synthesized by LPI-CVD above 670 °C
- Fig. S6 Raman spectra for Nb₂Pd₃Se₈ using different synthesis methods.
- Fig. S7 XPS analysis of Nb₂Pd₃Se₈ on SiO₂
- Fig. S8 Dimension of as fabricated FET channel material.

- 1. Reactants and solvent preparation
- Reactant A: Ammonium niobium oxalate (40 mM in D.I.)
- Reactant B : Ammonium palladium tetrachloride (60 mM in D.I.)
- Iodixanol (0.200 µL)
- 2. Precursor Mixing and Coating
- Mix Reactant A and Reactant B and iodixanol in a vial
- Use a pipette to pump the mixture 30 times to ensure thorough mixing.
- Dropwise add 400 µL onto a 2 cm x 2 cm SiO₂
- Spin coat the substrate at 3000 rpm for 30 seconds.
- 3. Calcination Process
- Heat to 600°C in a box furnace
- Ramping rate: 30°C/min
- Maintain for 3 hours
- 4. Preparation for Reaction in CVD System
- Load coated substrate in reaction zone
- Load Se powder (1 g) in alumina crucible (evaporation zone)
- 5. Reaction Process
- Evaporation zone: 500 °C
- Reaction zone: 560-670 °C
- Ramp up to desired temperature in 20 min
- Cool naturally after reaction

Fig. S1 Schematic diagram of the Nb₂Pd₃Se₈ nanowire growth using the LPI-CVD process



Fig. S2 Morphology of precursor coated substrate. (a) SEM image of the as-prepared coating with different molar concentrations of Nb: Pd precursor solution. (b) A table showing the average size of the particles based on the molar concentration of the precursor solution. (c) AFM images of the coating with Nb 40 mM and Pd 60 mM precursor solution.



Fig. S3 Cross section-SEM images of $Nb_2Pd_3Se_8$ nanowires grown on the substrate.



Fig. S4. (a) XRD patterns after the LPI-CVD process at 560, 580, 600, and 620 $^{\circ}\mathrm{C}$



Fig. S5 (a) SEM images of $Nb_2Pd_3Se_8$ synthesized by LPI-CVD at 690, 710, 730 °C (b) Process temperature-dependent wire length, width, and aspect ratio of CVD grown $Nb_2Pd_3Se_8$ nanowires..



Fig. S6 Comparison of Raman spectra for different synthesis methods of Nb₂Pd₃Se₈.



Fig. S7 XPS analysis of Nb₂Pd₃Se₈ on SiO₂ (a) XPS spectrum of CVD-grown Nb₂Pd₃Se₈. (b)-(d) Core level XPS spectra of the Nb 3d, Pd 3d and Se 3d regions.



Fig. S8 Dimension of FET device channel material. (a) AFM image and (b) height profile.