

A Novel Carbon-Assisted Chemical Vapor Deposition Growth of Large-Area Uniform Monolayer MoS₂ and WS₂

Jeonghwan Bae ¹ and Youngdong Yoo ^{2,*}

¹ Department of Energy Systems Research, Ajou University, Suwon 16499, Korea; qowjdghks123@naver.com

² Department of Chemistry, Ajou University, Suwon 16499, Korea

* Correspondence: yyoo@ajou.ac.kr

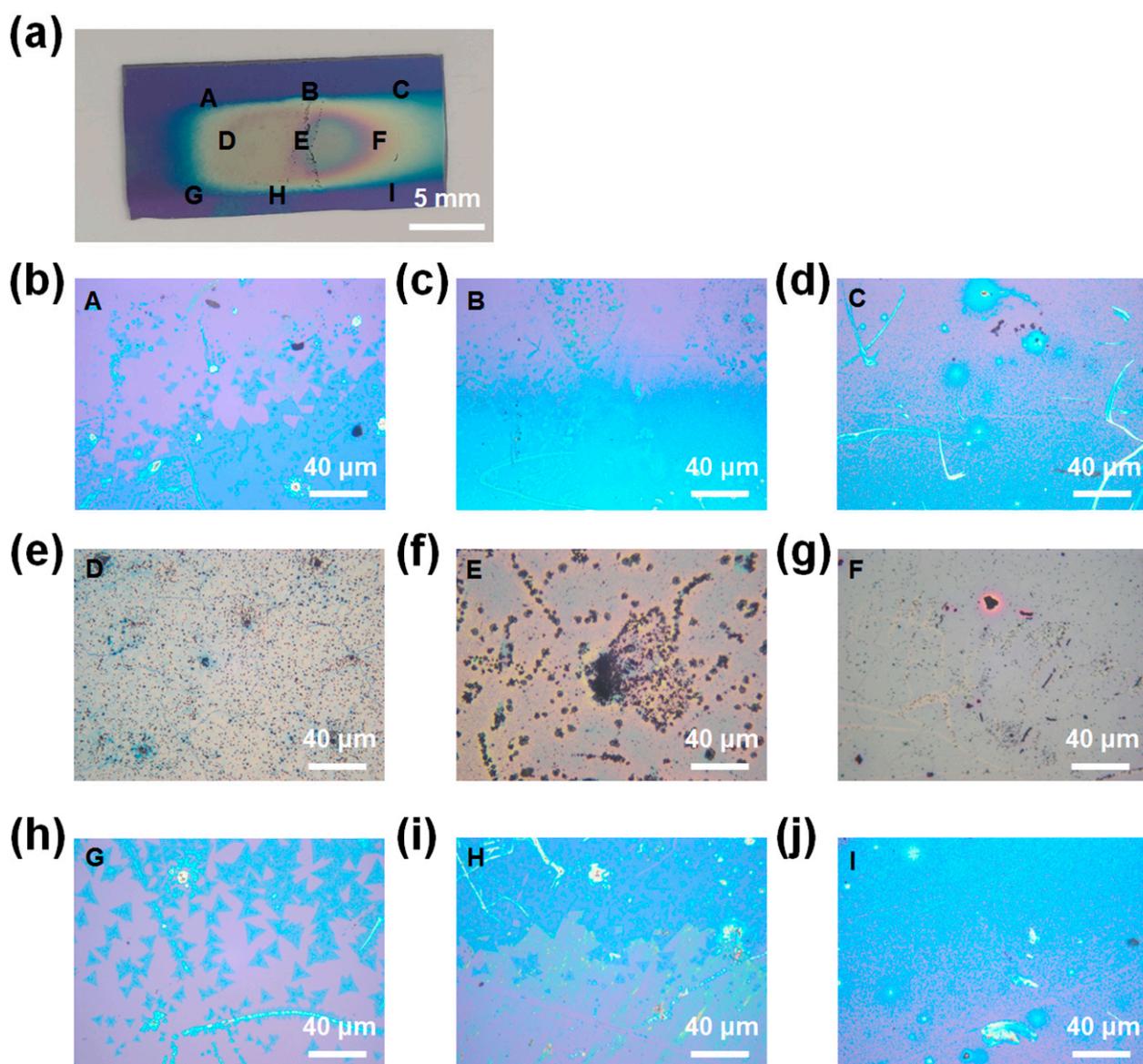


Figure S1. Additional optical characterization of the MoS₂ grown using the conventional CVD method. (a) Optical image of thick MoS₂ films and monolayer MoS₂ synthesized on a SiO₂/Si substrate using the conventional CVD method. (b-j) Magnified optical images of the region A, B, C, D, E, F, G, H, and I in (a), respectively.

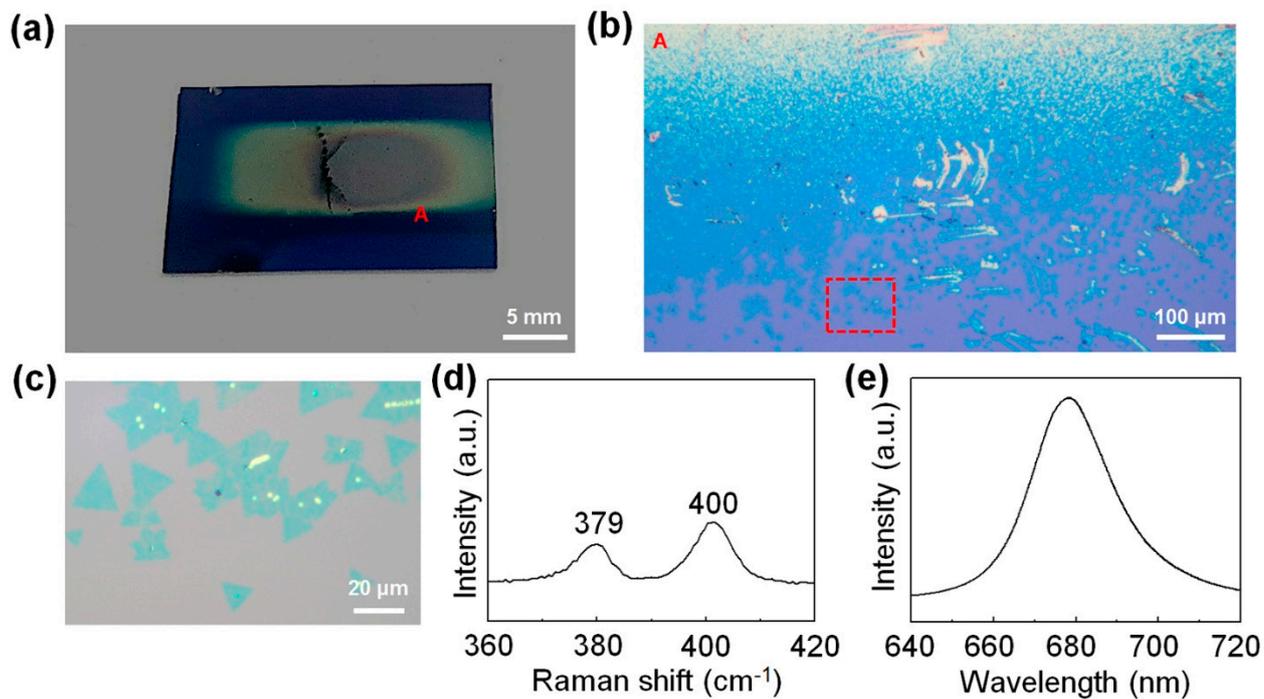


Figure S2. MoS₂ synthesized by the CVD method using H₂ as a carrier gas with Ar. (a) Optical image of the sample. (b) Magnified optical image of the region A of (a). (c) Magnified optical image of the dotted red rectangle in (b). (d) Raman spectrum and (e) PL spectrum of monolayer MoS₂ synthesized partially at the edge of the thick MoS₂ films.

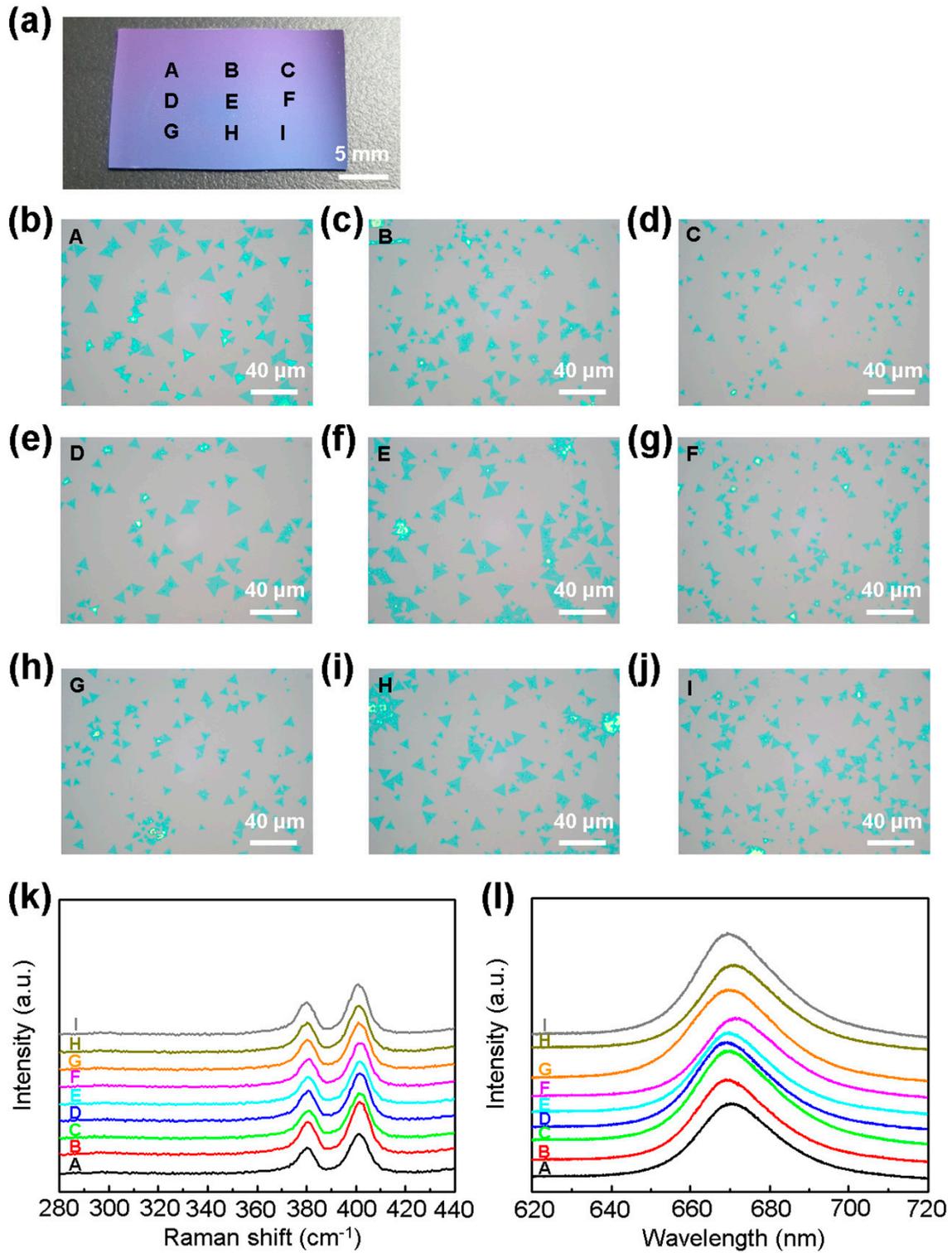


Figure S3. Additional optical characterization of the MoS₂ grown using the carbon cloth-assisted CVD method. (a) Optical image of monolayer MoS₂ synthesized on a SiO₂/Si substrate using the carbon cloth-assisted CVD method. (b-j) Magnified optical images of the region A, B, C, D, E, F, G, H, and I in (a), respectively. (k) Raman and (l) PL spectra of monolayer MoS₂ synthesized in the region A, B, C, D, E, F, G, H, and I in (a).

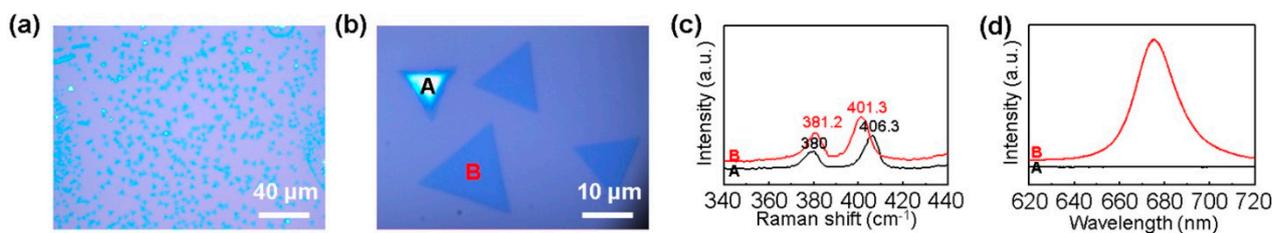


Figure S4. MoS₂ flakes grown using the carbon cloth-assisted CVD growth. (a) Low-magnification optical image of MoS₂ flakes. (b) High-magnification optical image of MoS₂ flakes. (c) Raman spectra taken at the point A and B of (b), respectively. (d) PL spectra taken at the point A and B of (b), respectively. These results show that the carbon cloth-assisted CVD growth produces mainly monolayer MoS₂ over a large area on the substrate and forms partially some MoS₂ multilayer. We believe that the partial formation of some MoS₂ multilayers is due to the local variation of experimental conditions on the substrate.

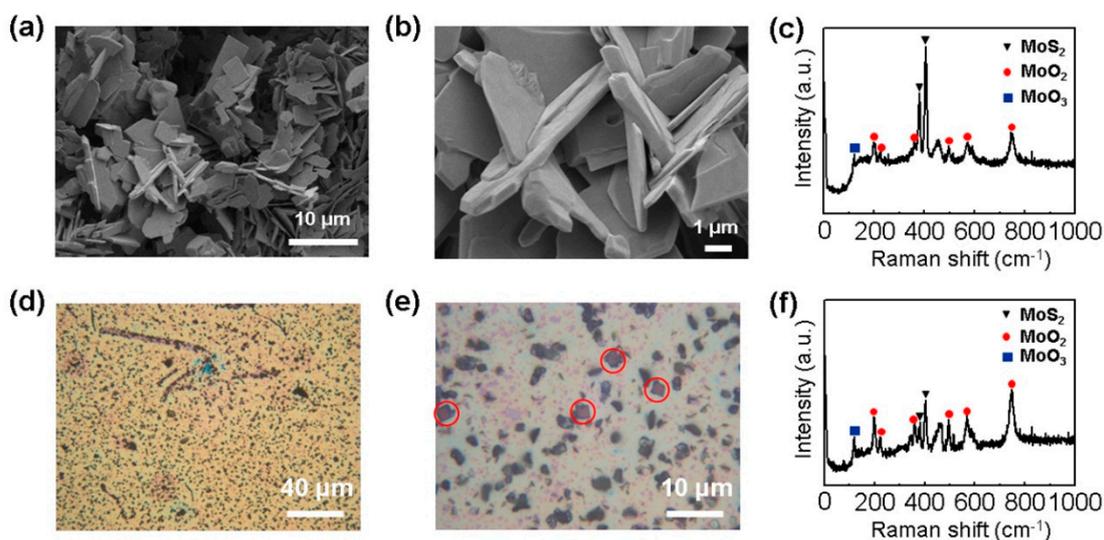


Figure S5. MoO₂-MoS₂ nanoplates grown after the carbon cloth-assisted CVD growth and after the conventional CVD growth. (a,b) Low-magnification and high-magnification SEM images of MoO₂-MoS₂ nanoplates grown on carbon cloth after the carbon cloth-assisted CVD growth. (c) Raman spectrum of MoO₂-MoS₂ nanoplates grown on the carbon cloth. (d,e) Low-magnification and high-magnification optical images of MoO₂-MoS₂ nanoplates (indicated by red circles) grown on a SiO₂/Si substrate after the conventional CVD growth. (f) Raman spectrum of MoO₂-MoS₂ nanoplates grown on the SiO₂/Si substrate. MoO₂-MoS₂ nanoplates were grown on carbon cloth instead of the SiO₂/Si substrate when the carbon cloth is used, whereas MoO₂-MoS₂ nanoplates were grown on the SiO₂/Si substrate when no carbon cloth is used.

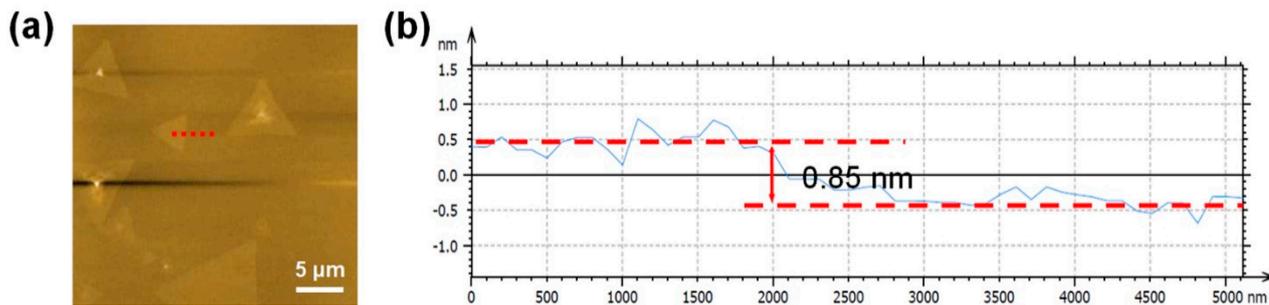


Figure S6. Additional AFM data of monolayer MoS₂ synthesized using the carbon cloth-assisted CVD method. (a) AFM height image of monolayer MoS₂. (b) Height line profiles along the dotted red line in (a).

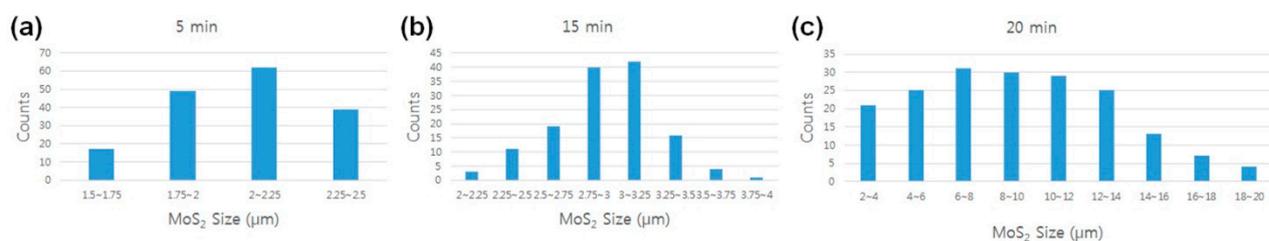


Figure S7. Size distribution of monolayer MoS₂ synthesized at reaction times of 5 min, 15 min, and 20 min using the carbon cloth-assisted CVD method, respectively.

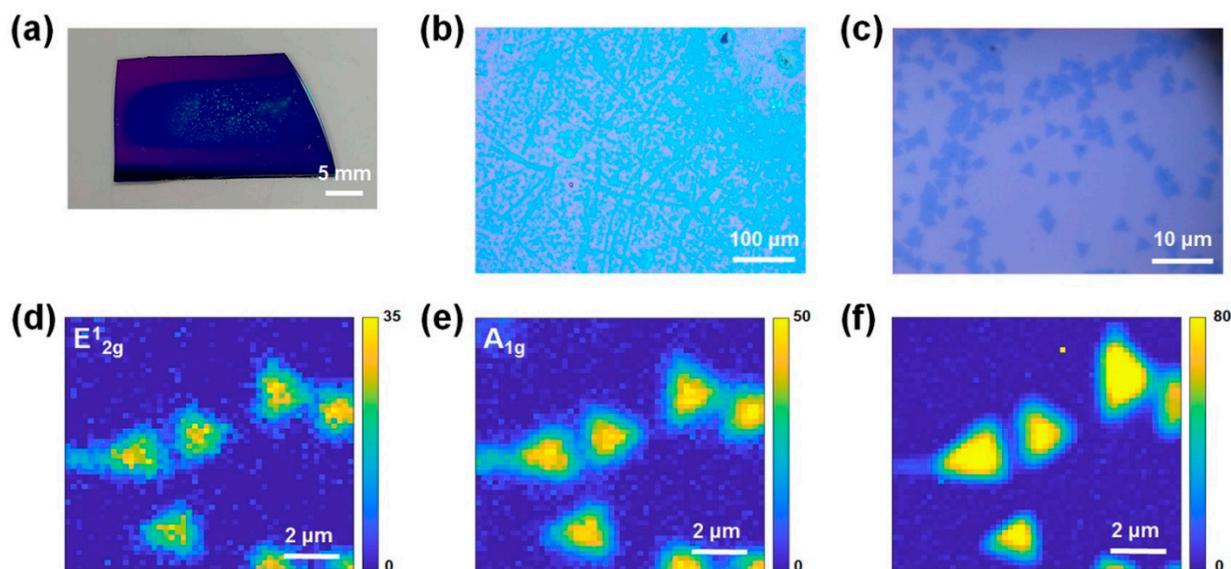


Figure S8. Graphite powder-assisted CVD growth of monolayer MoS₂. (a) Optical image of the sample. (b) Low-magnification and (c) high-magnification optical images of the monolayer MoS₂. (d,e) Raman maps of the E_{2g} mode and A_{1g} mode of MoS₂, respectively. (f) PL map of monolayer MoS₂.

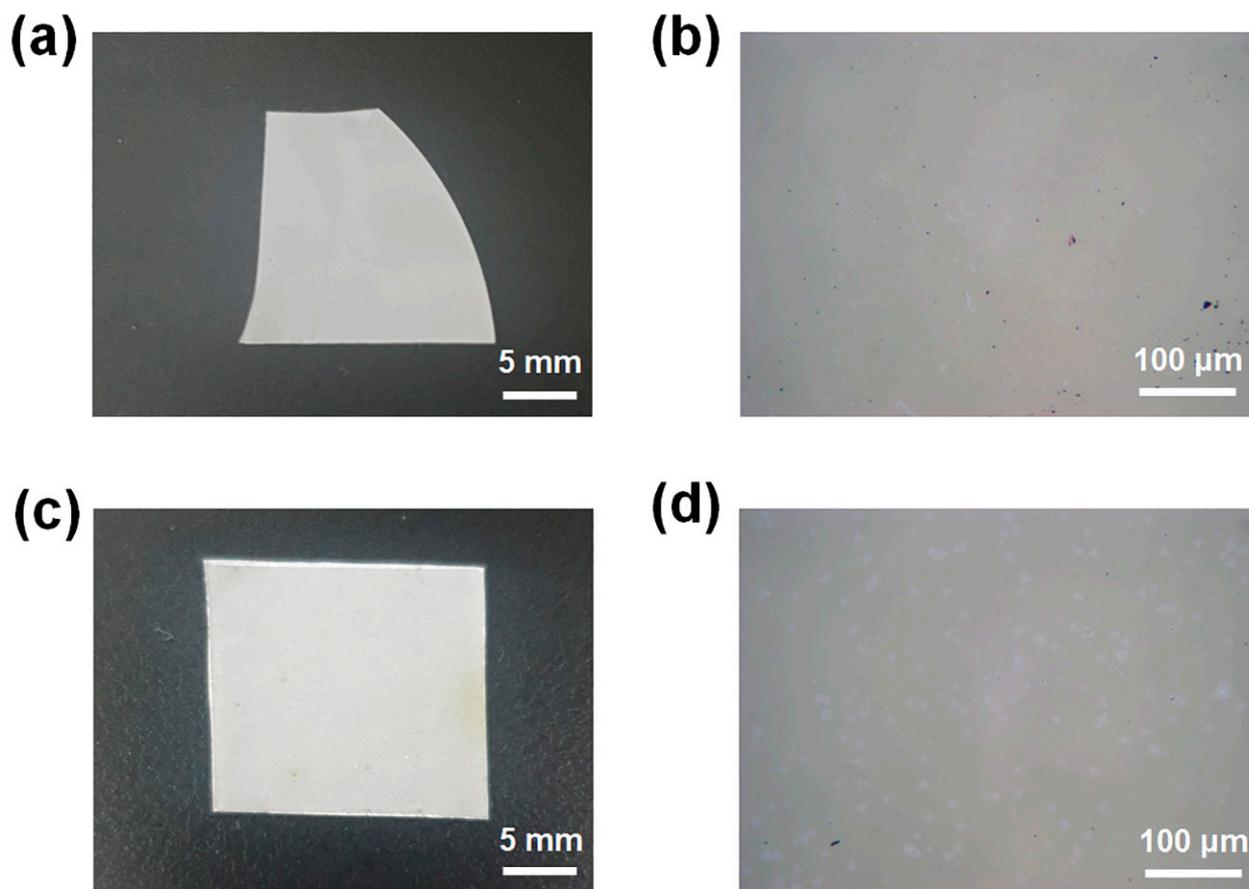


Figure S9. Monolayer WS₂ synthesized on a c-cut sapphire substrate using the conventional CVD method and the carbon cloth-assisted CVD method. (a) Optical image and (b) magnified optical image of the WS₂ synthesized on a c-cut sapphire substrate using the conventional CVD method. (c) Optical image and (d) magnified optical image of the WS₂ synthesized on a c-cut sapphire substrate using the carbon cloth-assisted CVD method.