Laser-Induced Formation of Molybdenum Trioxide Crystals

Mariam AlMahri, Rami Elkaffas, Yarjan Abdul Samad
Khalifah University, P.O. Box: 127788, AbuDhabi, UAE
Mariam.aalmahri@ku.ac.ae

Layered transition metal oxides (TMOs) have been utilized for centuries due to their abundance and diverse applications across various fields [1-4]. Developing efficient synthesis methods of layered TMOs is crucial for exploring novel properties and potential applications [5-7]. This work introduces Laser-Induced Molybdenum Trioxide (LIM), a direct laser synthesis method for producing transition metal oxides and crystals. We outline the laser synthesis protocol for successfully synthesizing layered transition metal oxides, using alpha-molybdenum trioxide as a representative example. The application prospects of MoO_3 crystals were demonstrated by integrating them into a polymer matrix as optical band-rejection filters for selective ultraviolet (UV) light filtering in the 200–220 nm range. The results highlight the potential of MoO_3-based composites for selective UV filtering, making them suitable for UV-sensitive devices, personal UV protection, and applications requiring precise wavelength control for optimal performance [8-10].

References

[1] P. Kumbhakar *et al.*, “Emerging 2D metal oxides and their applications,” *Mater. Today*, vol. 45, pp. 142–168, May 2021, doi: 10.1016/j.mattod.2020.11.023.
[2] K. Zhou, G. Shang, H. Hsu, S. Han, V. A. L. Roy, and Y. Zhou, “Emerging 2D Metal Oxides: From Synthesis to Device Integration,” *Adv. Mater.*, vol. 35, no. 21, p. 2207774, May 2023, doi: 10.1002/adma.202207774.
[3] J. Cao and J. Wu, “Strain effects in low-dimensional transition metal oxides,” *Mater. Sci. Eng. R Rep.*, vol. 71, no. 2–4, pp. 35–52, Jan. 2011, doi: 10.1016/j.mser.2010.08.001.
[4] J. S. Chen, Y. L. Cheah, S. Madhavi, and X. W. Lou, “Fast Synthesis of α-MoO_3 Nanorods with Controlled Aspect Ratios and Their Enhanced Lithium Storage Capabilities,” *J. Phys. Chem. C*, vol. 114, no. 18, pp. 8675–8678, May 2010, doi: 10.1021/jp1017482.
[5] S. Hu and X. Wang, “Single-Walled MoO_3 Nanotubes,” *J. Am. Chem. Soc.*, vol. 130, no. 26, pp. 8126–8127, Jul. 2008, doi: 10.1021/ja801448c.
[6] J. Li and X. Liu, “Preparation and characterization of α-MoO3 nanobelt and its application in supercapacitor,” *Mater. Lett.*, vol. 112, pp. 39–42, Dec. 2013, doi: 10.1016/j.matlet.2013.08.094.
[7] X. M. Wei and H. C. Zeng, “Large-Scale Organizations of MoO_3 Nanoplatelets with Single-Crystalline MoO_3(4,4‘-bipyridyl)$_{0.5}$,” *J. Phys. Chem. B*, vol. 107, no. 12, pp. 2619–2622, Mar. 2003, doi: 10.1021/jp0274177.
[8] S. Li, C. Shao, Y. Liu, S. Tang, and R. Mu, “Nanofibers and nanoplatelets of MoO3 via an electrospinning technique,” *J. Phys. Chem. Solids*, vol. 67, no. 8, pp. 1869–1872, Aug. 2006, doi: 10.1016/j.jpcs.2006.04.017.
[9] L. Huang *et al.*, “Three-dimensional MoO3 nanoflowers assembled with nanosheets for rhodamine B degradation under visible light,” *Mater. Res. Bull.*, vol. 108, pp. 38–45, Dec. 2018, doi: 10.1016/j.materresbull.2018.08.036.
[10] K. Kalantar-zadeh, J. Z. Ou, T. Daeneke, A. Mitchell, T. Sasaki, and M. S. Fuhrer, “Two dimensional and layered transition metal oxides,” *Appl. Mater. Today*, vol. 5, pp. 73–89, Dec. 2016, doi: 10.1016/j.apmt.2016.09.012.

Figures

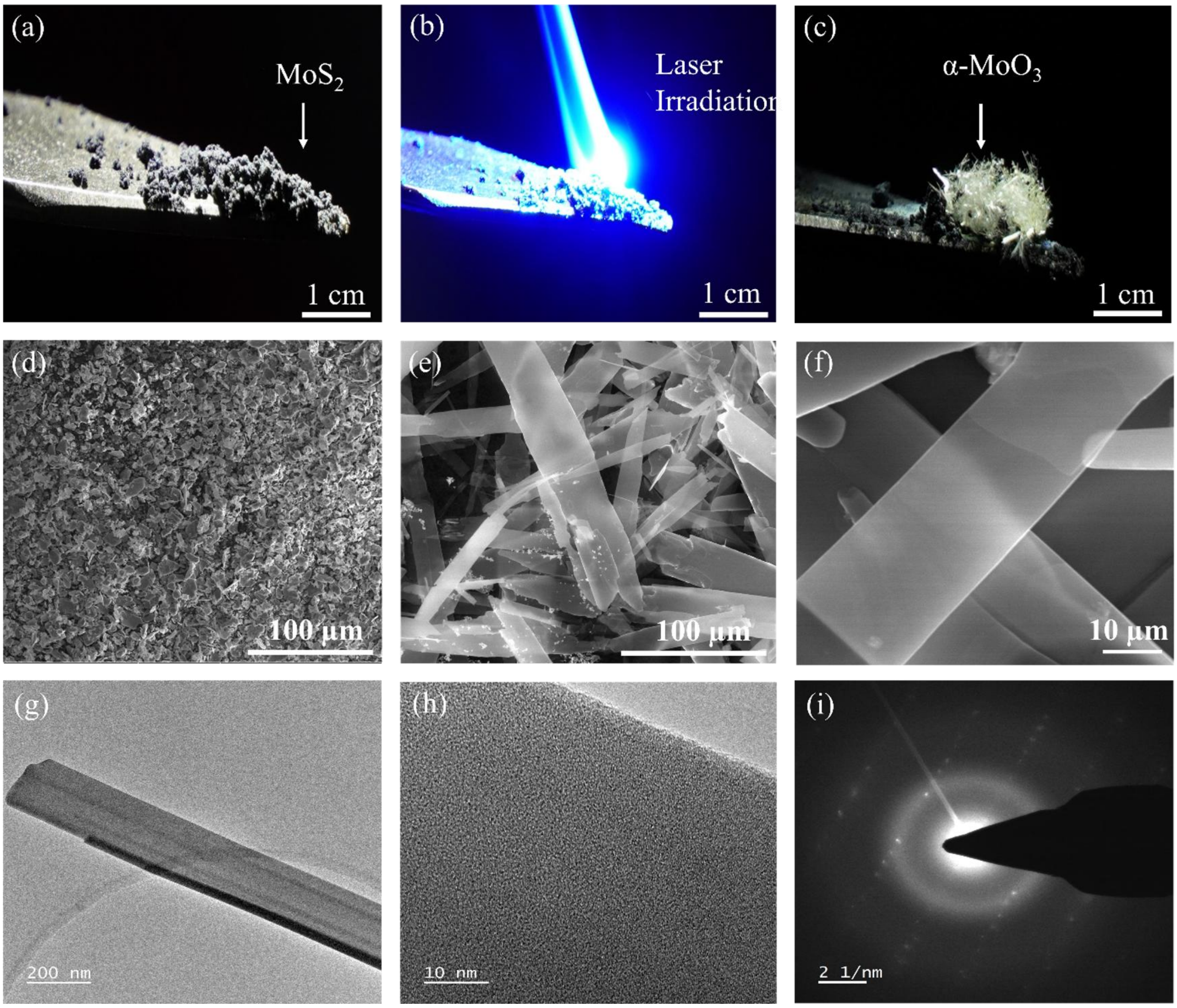

Figure 1: LIM synthesis process. (a) MoS_2 as starting material (b) Irradiation of MoS_2 (c) Formation of α-MoO_3 (d) SEM image of MoS2 (e,f) SEM image of α-MoO_3 belts at different magnifications. (g) Low magnification TEM of α-MoO_3 belts. (h) HRTEM of α-MoO_3 belts. (i) SAED of α-MoO_3 belts.