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PII: S2095-9273(17)30259-1
DOI: http://dx.doi.org/10.1016/j.scib.2017.05.016
Reference: SCIB 143

To appear in: *Science Bulletin*

Received Date: 1 April 2017
Revised Date: 20 April 2017
Accepted Date: 21 April 2017

Please cite this article as: D. Lv, H. Wang, D. Zhu, J. Lin, G. Yin, F. Lin, Z. Zhang, C. Jin, Atomic process of oxidative etching in monolayer molybdenum disulfide, *Science Bulletin* (2017), doi: http://dx.doi.org/10.1016/j.scib.2017.05.016

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Received 1 April 2017

Received in revised form 20 April 2017

Accepted 21 April 2017

Atomic process of oxidative etching in monolayer molybdenum disulfide

Danhui Lv,[a] Hulian Wang,[a] Dancheng Zhu,[a] Jie Lin,[a] Guoli Yin,[a, c] Fang Lin[b], Ze Zhang,[a] Chuanhong Jin[a,*]

[a] State Key Laboratory of Silicon Materials, School of Materials Science and Engineering, Zhejiang University, Hangzhou 310027, China

[b] College of Electronic Engineering, South China Agricultural University, Guangdong 510642, China

[c] Department of Materials Science and Engineering, Stanford University, Stanford, CA 94305, USA

[*] Corresponding author: Chuanhong Jin, E-mail: chhjin@zju.edu.cn

Abstract

The microscopic process of oxidative etching of two-dimensional molybdenum disulfide (2D MoS_2) at an atomic scale is investigated using a correlative transmission electron microscope (TEM)-etching study. MoS_2 flakes on graphene TEM grids are precisely tracked and characterized by TEM before and after the oxidative etching. This allows us to determine the structural change with an atomic resolution on the edges of the domains, of well-oriented triangular pits and along the grain boundaries. We observe that the etching mostly starts from the open edges, grain boundaries and pre-existing atomic defects. A zigzag Mo edge is assigned as the dominant termination of the triangular pits, and profound terraces and grooves are observed on the etched edges. Based on the statistical TEM analysis, we reveal possible routes for the kinetics of the oxidative etching in 2D MoS_2, which should also be applicable for other 2D transition metal dichalcogenide materials like $MoSe_2$ and WS_2.

Keyword: Molybdenum disulfide, Oxidative etching, Transmission electron microscopy, Atomic process

1. Introduction

Atomically thin transition metal dichalcogenide (TMD) materials, as an emerging family of two-dimensional (2D) materials, have been extensively studied in recent years. Their unique polymorph