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Atomic process of oxidative etching in monolayer molybdenum disulfide

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Abstract

The microscopic process of oxidative etching of two-dimensional molybdenum disulfide (2D MoS₂) at an atomic scale is investigated using a correlative transmission electron microscope (TEM)-etching study. MoS₂ 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 MoS₂, which should also be applicable for other 2D transition metal dichalcogenide materials like MoSe₂ and WS₂.

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

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