Investigation of impact of orientation on electronic properties in epitaxially grown MoO_2 films

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[Introduction] The structural instability of rutile compounds has been investigated intensively to reveal correlations between structural and electronic phase transitions, as represented by a metal-insulator transition in VO_2. Recent discovery of superconductivity in strained rutile-type RuO_2 films further draws interests of lattice engineering for exploring exotic properties [1]. In order to investigate impact of lattice strain on phase instability, orientation control is a starting point. In this study, we focus on MoO_2 with distorted rutile-type structure. The epitaxial growth and transport properties of MoO_2 with various orientations are reported.

[Experiment] Epitaxial MoO_2 thin films were prepared by using pulsed-laser deposition (PLD) on α-Al_2O_3 (0001), TiO_2 (100), TiO_2 (001), and TiO_2 (110) substrates. During the deposition, the substrate temperature was kept at 800 °C, and the oxygen pressure was maintained at 1×10^{-4} Torr.

[Results and discussion] Figure 1 shows x-ray diffraction (XRD) profiles of as-deposited MoO_2 films on various substrates. Single-phase MoO_2 thin films with (100), (010), ($\bar{2}$01), and (011) orientations were obtained. The films grown on α-Al_2O_3 (0001) and TiO_2 (100) substrates exhibited relatively higher crystallinity. Figure 2a shows temperature dependence of resistivity for all the films shown in Fig. 1. Among them, the film grown on TiO_2 (001) substrate exhibited the highest conductivity and the highest MR (~10% at 1.9 K and 9 T, see Fig. 2b). Further details in structural and electronic properties will also be discussed.

[1] M. Uchida, *et al.*, *Phys. Rev. Lett.* **125,** 147001 (2020).

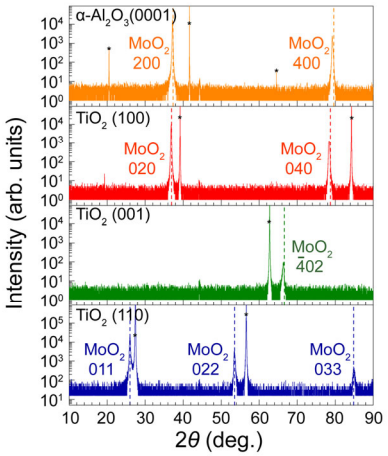

Fig. 1 XRD profiles of MoO_2 films grown on various substrates. The substrate reflections are marked with star symbol.

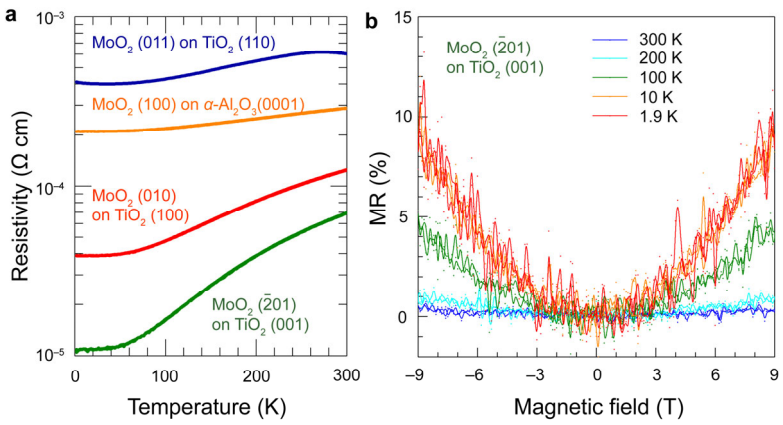

Fig. 2 Temperature dependence of (a) resistivity for MoO_2 films grown on various substrates and (b) MR for the ($\bar{2}$01) oriented MoO_2 film grown on TiO_2 (001) substrate.