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Investigation of optical properties and electronic transitions in bulk and nano-microribbons of molybdenum trioxide

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Abstract

In this work, we report on crystalline quality and optical characteristics of molybdenum trioxide (MoO3) bulk and nano-microribbons grown by rapid thermal oxidation (RTO). The developed RTO procedure allows one to synthesize highly crystalline (α-phase) bulk and nano-microribbons of MoO3. For R–Γ indirect transitions in bulk single crystals of MoO3, it has been found that the width of the bandgap along the E⊥c polarization, associated with transitions Rv1–Γc1, is lower than the width of the band gap in polarization E ⊥ c, associated with transitions Rv2–Γc2. This result is indicative of splitting of the absorption edge due to α-MoO3 structural anisotropy. Studies of the polarization dependence of the absorption in nano-microribbons (d ≈ 15–500 nm) demonstrated that the energy gap corresponding to Rv1–Xc1 (E⊥c) transition is smaller than that of Rv2–Xc2 (E ⊥ c) transition. Similar dependence has been found for the R–Y indirect transitions. The results of the investigation of the reflectance spectra in the energy range from 3 to 6 eV are shown. By using the Kramers–Kronig method, the optical functions were derived from the reflection spectra of nano-microribbons, and the polarization dependence of direct energy transitions at the point R in the Brillouin zone are determined. The alternation in splitting caused by polarization of the absorption edge related to indirect transitions due to polarization opens new prospects for the design and fabricating interesting optoelectronic devices based on α-MoO3 bulk and nano-microribbons with characteristics dependent on the polarization of light waves.