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Nanostructured $CuWO_4/WO_{3-x}$ films prepared by reactive magnetron sputtering for hydrogen sensing

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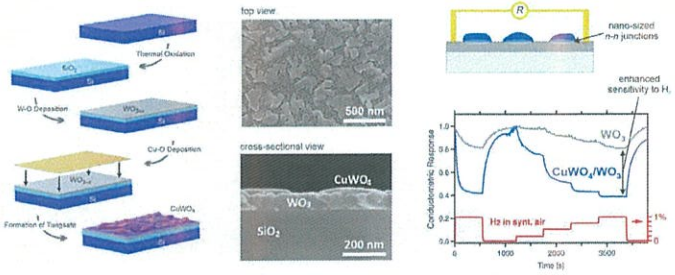
HIGHLIGHTS

- Two-step reactive sputter deposition used for $CuWO_4/WO_{3-x}$ bilayer films synthesis.
- Nanostructured $CuWO_4$ islands were formed on top of WO_3 thin film.
- $CuWO_4/WO_{3-x}$ tested for the H_2 gas response for the first time.
- Sensing mechanism based on the formation of nano-sized *n-n* junction is proposed.
- Only dry techniques were employed for deposition → high-purity films were prepared.

GRAPHICAL ABSTRACT



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ABSTRACT

High-purity films consisting of copper tungstate ($CuWO_4$) and sub-stoichiometric tungsten oxide (WO_{3-x}) were prepared by reactive sputter deposition. An original two-step deposition process was applied for their synthesis. First, a tungsten oxide thin film was deposited by dc magnetron sputtering from a W target in an Ar + O_2 gas mixture, afterward, rf sputtering of a Cu target in an Ar + O_2 gas mixture was employed to form a discontinuous $CuWO_4$ layer at the top. This results in a formation of nanostructured branched islands of the tungstate. Bilayers with various layer thicknesses were investigated for the sensitivity to hydrogen gas as a conductometric sensor. The sensitivity changes remarkably with the thicknesses of individual layers. The maximum sensitivity was observed for the films with a layer thickness ratio of 5 nm/20 nm. The response was enhanced more than eight times compared to a 20 nm-thick tungsten oxide alone film. An explanation based on the formation of nano-sized *n-n* junctions is provided. In addition, a microscopy study of the bilayer growth is presented in detail.

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