YSZ 固体電解質上に成長した六方晶酸化タングステン エピタキシャル薄膜の光・電子物性の可逆的酸化還元制御

Reversible Redox Control of Optoelectronic Properties of Hexagonal Tungsten Oxide Epitaxial Films Grown on YSZ Solid Electrolyte

北大院情報[1]，北大電子研[2] ○(D3) キムゴウン[1]，ジョヘジュン[2]，太田裕道[2]

IST-Hokkaido U.[1], RIES-Hokkaido U.[2], ○G. Kim[1], H.J. Cho[2], H Ohta[2]

E-mail: woom93@gmail.com

Controlling the oxygen concentration of metal oxides is one of the most effective ways to modulate their optoelectronic properties. However, such redox control is difficult to apply for metal oxide epitaxial films because it induces serious damage to the crystal lattice, especially around the film/substrate interface due to the large volume change upon redox treatment. To overcome this problem, we hypothesized that the use of metal oxides having a stress-resistant crystal structure would be effective. Here we show reversible redox control of optoelectronic properties of hexagonal tungsten oxide (h-WO_x) with honeycomb structure epitaxial films. We fabricated highly c-axis oriented h-WOx epitaxial films on (111) YSZ single crystal substrate. Upon electrochemical redox treatment at 300 °C with applying ±3 V to the YSZ solid electrolyte as shown in Figure (a), the oxygen content x of h-WO_x was reversibly controlled in the range of $2.93 \leq x \leq 2.99$ without inducing damage to the crystal lattice. Simultaneously, the electrical conductivity was controlled from ~400 S cm^{-1} to an insulator (Figure (b)), and the optical transmission at 1500 nm in wavelength was controlled in the range of 35 − 70%. The present results would be useful to develop metal oxide epitaxial films-based electrochemical optoelectronic devices.

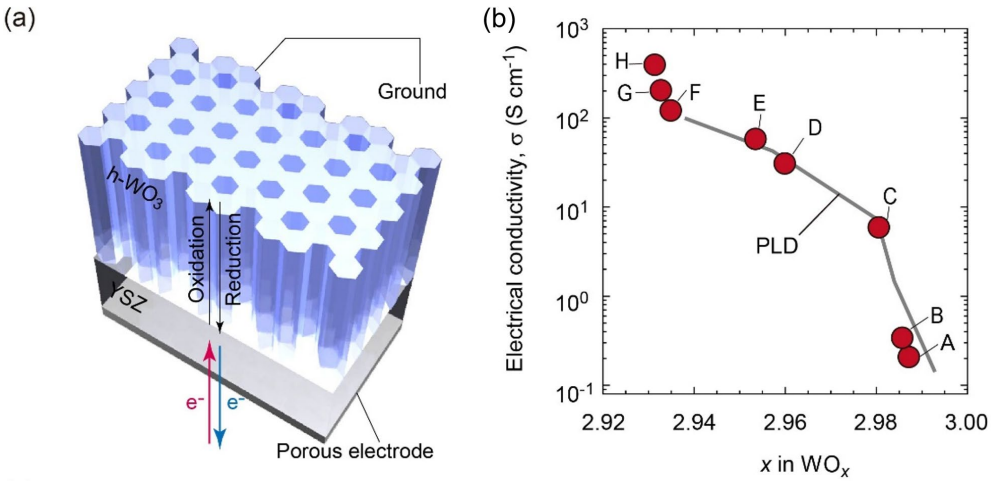

Figure (a) Schematic illustration of the solid-state electrochemical cell composed of h-WO_3/YSZ substrate (b) Electrical conductivity of the electrochemically reduced WO_x films (Gray solid line: h-WO_x epitaxial films by the PLD method with modulated oxygen pressure during the film growth).