Fabrication of Titanium Oxide Nanotube Micro Gas Sensors by Anodization

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The metal oxide semiconductor gas sensor is one of gas sensors and it has useful features of simple structure and high sensitivity. Miniaturization or integration of gas sensors gives a lot of advantages such as low power consumption, improvement of portability, high reliability, and simultaneous measurement of multicomponent. Miniaturization and integration of gas sensors require position controllability and uniformity of materials. It is important to precisely control the position of a device. Therefore, it is important to develop a hybrid process between photoli-thography and bottom-up process. This requires that the bottom-up process is compatible with photolithography. Then, we used an anodization process, which is compatible with photolithography, as a bottom-up one. The anodization process forms nanotubes with homogenous pore diameter and period. It has been reported that gas sensors using anodic titanium oxide nanotubes have good performance. In this study, we miniaturized metal oxide semiconductor gas sensors using an anodic titanium oxide nanotube film by the hybrid process.

Figure 1 illustrates the miniaturized gas sensor fabrication process. First, a titanium film was deposited on the substrate by DC magnetron sputtering and the titanium film was patterned to form the titanium wire. A protective silicon dioxide layer was deposited on the titanium wire expect a region which was anodized. After that the part of the titanium wire was anodized in ammonium fluoride and water containing ethylene glycol solution. Finally, anodic titanium oxide nanotube layer was crystallized. Figure 2 shows the response of the miniaturized hydrogen gas sensor at 300 ºC. From Fig. 2, we can see that the conductance change as large as the 20 times when the hydrogen concentration was 10 %. This indicates that a micro gas sensor can be fabricated by the anodization process. Furthermore, the sensed current of about 1 A indicated that a picoamperemeter and formation of interdigitated electrodes are not necessary for sensing current.

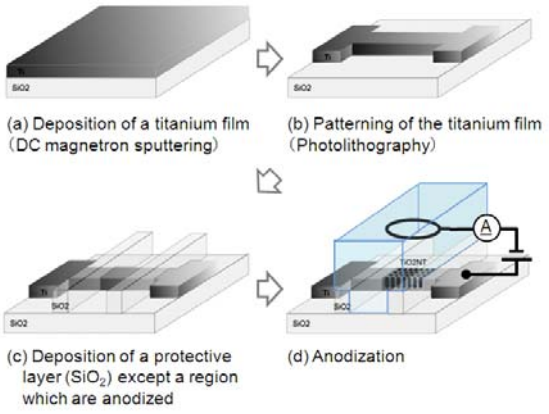

Fig. 1 Fabrication process of micro gas sensors by local anodization of titanium wires

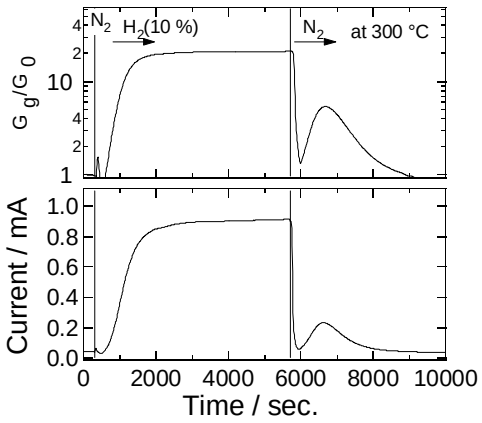

Fig. 2 The response characteristics of a miniaturized hydrogen gas sensor at 300 ºC.