The properties of transparent TiO₂ films for Schottky photodetector

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A B S T R A C T
In this data, the properties of transparent TiO₂ film for Schottky photodetector are presented for the research article, entitled as “High-performing transparent photodetectors based on Schottky contacts” (Patel et al., 2017) [1]. The transparent photoelectric device was demonstrated by using various Schottky metals, such as Cu, Mo and Ni. This article mainly shows the optical transmit-tance of the Ni-transparent Schottky photodetector, analyzed by the energy dispersive spectroscopy and interfacial TEM images for transparency to observe the interface between NiO and TiO₂ film. The observation and analyses clearly show that no pinhole formation in the TiO₂ film by Ni diffusion. The rapid thermal process is an effective way to form the quality TiO₂ film formation without degradation, such as pinholes (Qiu et al., 2015) [2]. This thermal process may apply to form functional metal oxide layers for solar cells and photodetectors.

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Specifications Table

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The optical profile and the interfaces of the transparent Schottky device (NiO/TiO2/FTO) were analyzed.

Pure Ti film formed a quality TiO2 film by rapid thermal process.

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The data present the transparent Schottky contact for the photodetector device.

Rapid thermal process is effective to form the quality TiO2 film without forming pinholes inside the layer [1].

Elemental analyses clearly show the abrupt junction formation through the interfaces.

The data is useful to design for transparent photoelectric device applications, including solar cells, photodetectors, and transparent semiconductor fabrications.

The datasets were acquired from the Schottky device of a thin Ni layer onto the TiO2 film, which is a route for high-performing transparent photoelectric devices. The fluorine doped-Tin oxide (FTO) glass was used as a substrate, where FTO layer serves as a transparent conductor. A quality TiO2 film was grown by rapid thermal process (RTP). Pure Ti film was initially coated on the FTO layer by sputtering method with 300 W onto a 4-in. Ti target (99.99%, iTASCO). After then RTP procedure was applied to transform TiO2 film at 700 °C for 10 min to ensure the transparency of Schottky type photodetector (Metal film/TiO2/FTO/glass). Various metal oxide films were formed by using different metal species, such as Cu, Mo and Ni. In order to investigate the stability of TiO2 film, the fast diffusion Ni metal was studied for the phenomenon of intrusion into TiO2 film. Fig. 1 and Fig. 2 are provided for the configuration of the transparent Schottky devices (Ni/TiO2/FTO/glass). The optical property was presented in Table 1. Fig. 3 and 4 give the quality of TiO2 film and interfaces. By applying the RTP

Fig. 1. Photograph images of Ti film-coated FTO glass and TiO2-formed FTO glass. The RTP procedure was performed to transform the pure Ti film to the TiO2 film.
process, there is no serious degradation of TiO$_2$ layer without pinholes, different from the e-beam evaporation method\[2\].

2. Experimental design, materials and methods

2.1. Measurements

High-performing transparent Schottky photodetector was fabricated [1]. In order to observe the interfaces of the Schottky device (NiO/TiO$_2$/FTO/Glass), a field-emission transmission electron microscope (FETEM, JEOL, JEM-2100F) was used. The TEM samples were prepared using a focused ion beam technique, allowing for high-resolution imaging of the sample's topography and composition. The samples were then analyzed using energy dispersive spectroscopy (EDS) to determine the elemental composition at various depths. The transmittance profiles of the transparent photodetector NiO/TiO$_2$/FTO/Glass are presented in Table 1.

Table 1
Transmittance profiles of the transparent photodetector of NiO/TiO$_2$/FTO/Glass.

| Wavelength ($\lambda$) | $\lambda > 380$ nm | $\lambda > 600$ nm | $\lambda > 780$ nm | $380 \leq \lambda \leq 780$ nm |
|-----------------------|-------------------|-------------------|-------------------|-----------------------------|
| Transmittance [%]     | 81.6              | 84.3              | 84.8              | 76.6                        |

Fig. 2. Transparent photodetector (Ni/TiO$_2$/FTO/Glass) for (a) Schematics, (b) Photograph image, and (c) Transmittance profiles.

Fig. 3. Cross-sectional TEM image and elemental line mapping using energy dispersive spectroscopy of Ni/TiO$_2$/FTO layers.

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Fig. 3. Cross-sectional TEM image and elemental line mapping using energy dispersive spectroscopy of Ni/TiO$_2$/FTO layers.
beam system (FIB, FEI, Quanta 3D FEG). The elemental compositions as line profile in the cross section of the transparent Schottky photodetector (NiO/TiO$_2$/FTO/Glass) were determined by an energy dispersive spectroscopy (EDS) attachment to the FETEM. Optical characterization was carried out using a UV-visible spectrophotometer (Shimadzu, UV-1800) by recording the transmission of the transparent Shcottky device in the range 300–1400 nm.

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**Transparency document. Supplementary material**

Transparency data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2017.05.033.

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