Explore the Band Engineering of Solution Processed TiO₂ for Efficient Schottky photodiode by Ultra-violet Spectroscopy

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Abstract
In this study, titanium oxide films were deposited on silicon wafer by using a liquid phase deposition technology. The UPS spectrum of TiO₂ film was shown in Fig. 2. The insert shows the secondary cutoff region for determining its work function (close to the molecular energy level of the conduction band for N-type semiconductors). UPS analysis show that the conduction band of TiO₂ is located at 2 eV. Fig. 3 shows the UV-VIS spectrum of TiO₂ film onset of the absorption spectrum about 3.2 eV. Fig. 4 shows the band alignment diagram of TiO₂ film according to UPS & UV-VIS spectrum analysis data. The holes move toward TiO₂ film and the electrons move along toward the silicon wafer. We investigate LPD-TiO₂ film on the I-V measurement, and observed forward bias and reverse bias current characteristic as shown in Fig. 5. The TiO₂ film under dark have high leak current from reverse bias about 1 x 10⁻¹ A/cm² and low forward bias current 1 x 10⁻⁶ A/cm². LPD-TiO₂ film forward bias current was increased after illumination, from 1 x 10⁻⁶ A/cm² increase to 1 x 10⁻⁵ A/cm² as shown in Fig. 6.

3. Results and Discussion
In this study, amorphous TiO₂ film was deposited on Si wafer by using a liquid phase deposition technology. The UPS spectrum of TiO₂ film was shown in Fig. 2. The insert shows the secondary cutoff region for determining its work function (close to the molecular energy level of the conduction band for N-type semiconductors). UPS analysis show that the conduction band of TiO₂ is located at 2 eV. Fig. 3 shows the UV-VIS spectrum of TiO₂ film onset of the absorption spectrum about 3.2 eV. Fig. 4 shows the band alignment diagram of TiO₂ film according to UPS & UV-VIS spectrum analysis data. The holes move toward TiO₂ film and the electrons move along toward the silicon wafer. We investigate LPD-TiO₂ film on the I-V measurement, and observed forward bias and reverse bias current characteristic as shown in Fig. 5. The TiO₂ film under dark have high leak current from reverse bias about 1 x 10⁻¹ A/cm² and low forward bias current 1 x 10⁻⁶ A/cm². LPD-TiO₂ film forward bias current was increased after illumination, from 1 x 10⁻⁶ A/cm² increase to 1 x 10⁻⁵ A/cm² as shown in Fig. 6.

3. Conclusions
In summary, the results showed that LPD-TiO₂ have high reverse bias leak current and low forward bias current before illumination. LPD-TiO₂ film has significantly increased forward bias current after illumination. By adding an annealing step the forward current can be improved.

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References
Fig. 1 LPD-TiO$_2$ film flowchart

Fig. 2 UPS spectrum of TiO$_2$ film.

Fig. 3 UV-vis spectrum of TiO$_2$ film onset of the absorption spectrum.

Fig. 4 Band alignment of LPD-TiO$_2$ film with p-type wafer.

Fig. 5 Dark I-V characteristic of LPD-TiO$_2$ film

Fig. 6 I-V characteristic of LPD-TiO$_2$ film under illumination