UNIVERSITI TEKNOLOGI MARA

ENGINEERING AND TUNING OF TA_2O_5 MORPHOLOGY VIA ANODIZATION: APPLICATION FOR UV SENSOR

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ABSTRACT

In this thesis, the Master candidate pursued the development of ultraviolet (UV) sensor or photo detector based on transition metal oxide, which is tuned and engineered in order to obtain enhanced properties. The author made informed choices regarding the usage of tantalum pentoxide (Ta_2O_5) as the model transition metal oxides. Ta_2O_5 is well investigated metal oxide, and a broad range of information regarding its fundamental properties, synthesis methods and applications is available. Its complimentary electronic nature is also required for the proposed studies in this thesis: Ta_2O_5 is a wide band gap metal oxide with band gap somewhere between 3.8 ~ 5.3 eV. This Master research focuses on the engineering and tuning morphology, crystallinity and stoichiometry of transition metal oxides in order to investigate and devise scenarios that result in the highest efficiencies for the above-mentioned model device. The author of this thesis thoroughly reviewed the physical and chemical properties, as well as methods of synthesis of Ta_2O_5. Additionally, she also studied factors that have been previously employed for enhancing the targeted materials functionalities. This includes tuning the synthesis` parameters such as changes in volume of concentration, duration and temperature. In order to realize the aforementioned goals and create new knowledge, the author implemented his research work in two distinct investigations: the first investigation involved with optimizing the nanostructured of Ta_2O_5 by using anodization method. At the time when this Master research commenced, the majority of work in the field of metal oxide UV sensors has been devoted to nanostructured TiO_2 and ZnO metal oxide, whilst the number of reports on the UV sensing properties of nanostructured Ta_2O_5 was significantly lower. As a result, the Master candidate studied the UV sensing device based on nanostructured Ta_2O_5, synthesized *via* anodization method with different fabrication parameters. As the aim of this thesis, the author demonstrated control over crystallinity, pore sizes and surface roughness of the films by altering the volume concentration and duration of anodization. The author provided organized and step by step discussion on how NH_4F, H_2O and H_2SO_4 influence the growth of nanotubular by performing the experiments with different concentration of NH_4F, H_2O and H_2SO_4. The author found out that optimized condition to successfully synthesize nanotubular Ta_2O_5 is 50 mL EG + 1.35 wt% NH_4F + 4 vol% H_2O + 0.5 vol% H_2SO_4, with annealing temperature of 500 °C for 2 h. Moreover, UV sensor fabricated from nanotubular Ta_2O_5 anodized for 1.5 hour was yielding the highest sensor`s efficiency with fastest responsivity, highest repeatability value and lowest resistance value. In summary, the author strongly believes that this thesis provides the readers with an in-depth knowledge of capabilities that tuning and engineering Ta_2O_5 provide in enhancing the performance of such materials for UV sensor. This study is expected to open the way for the development of large-scale nanotubular Ta_2O_5 UV sensor with optimum UV responsivity and stability.

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