TiO_2 Nanotube (T_NT) surface treatment revisited: Implications of ZnO, $TiCl_4$, and H_2O_2 treatment on the photoelectrochemical properties of T_NT and T_NT/CdSe

(Invited presentation)

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The surface treatment of anodized TiO_2 nanotube (T_NT) is very desirable for enhancing its photoelectrochemical properties and often is a prerequisite to deposition of any overlying layer for photoactivity efficiency improvement. This study provides a comparative analysis into the effects of such surface treatments and the mechanistic insights behind the observed improvements in the performance of the treated T_NTs. T_NT surface treatment using three approaches, viz., $TiCl_4$, $Zn(NH_3)_4^{2+}$, and H_2O_2 is examined. $TiCl_4$ and $Zn(NH_3)_4^{2+}$ treatment results in formation of discontinuous islands of the respective oxides with 5-10nm and 15-20nm diameter particles. $TiCl_4$ treatment demonstrates an increase of 7.4% in photovoltage and is the most effective of the three approaches. $Zn(NH_3)_4^{2+}$ treatment also results in ~2% increase in photovoltage. However, a surface treatment of T_NT using H_2O_2 results only in a favourable shift in flatband potential (80mV). The T_NTs are rendered ineffective as H_2O_2 treatment causes the destabilization of the T_NT at the base. Finally, the activity of an overlying chalcogenide layer is improved with the $TiCl_4$ and $Zn(NH_3)_4^{2+}$ treatment (and not with H_2O_2) as evident from the photoelectrochemical responses: ($J_{T\_NT/TiO2/CdSe} > J_{T\_NT/ZnO/CdSe} > J_{T\_NT/CdSe} > J_{T\_NT/H2O2/CdSe}$).

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