Improvement of photo-response in titanium dioxide for cell culture substrates

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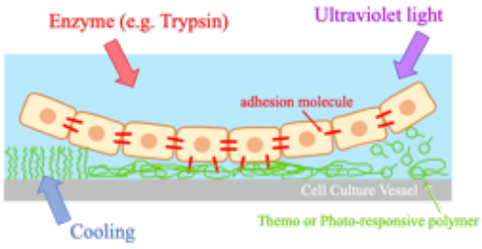
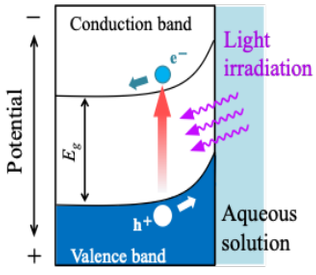
Adhesion/Exfoliation of Cells

Several regenerative medical techniques have been recently developed to revive the functions of damaged organs in several diagnoses. The techniques using cells have played an important role for such research conducted in a variety of medical fields. Several techniques have been employed to attach/detach cells to/from a substrate. Cells cultured on a substrate are generally detached from the substrate into a sheet by the destruction of protein between the cells and the substrate using enzymes such as trypsin. However, the enzymes also damage the adhesion molecules among the cells.



Photocatalytic Reaction Semiconductors

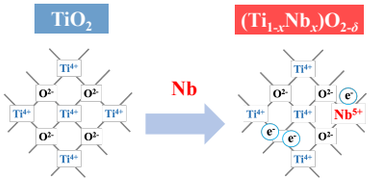


Up-hill potential gradient

When an n-type semiconductor is immersed in an aqueous solution, an up-hill potential gradient is produced towards the surface in the conduction and the valence. Under UV (wavelength < 390 nm) irradiation, electrons and holes are formed in the conduction and valence bands, respectively. These photogenerated charges are then spatially separated by the potential gradient. We consider that the formation of titanium hydroxide groups and the charge separation in the TiO_2 surface region affect the adhesion/proliferation/detachment behavior of cells.

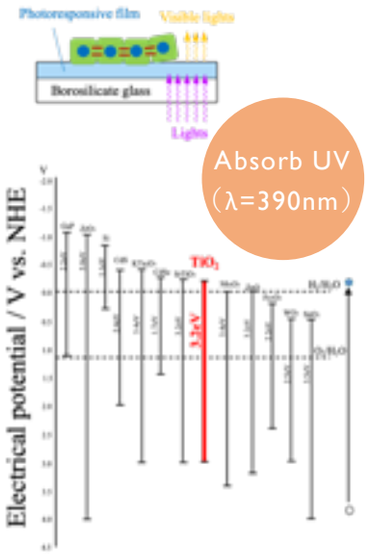
Improved optical response

By selecting Nb, which has an ionic radius close to Ti and no biotoxicity has been reported, a new impurity level is formed.



○objective

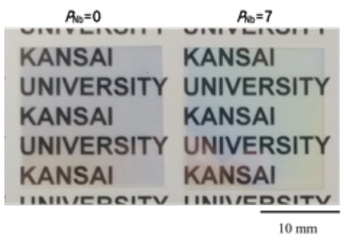
Nb doped TiO_2 films by means of a conventional RF sputtering, and to investigate fundamental properties.

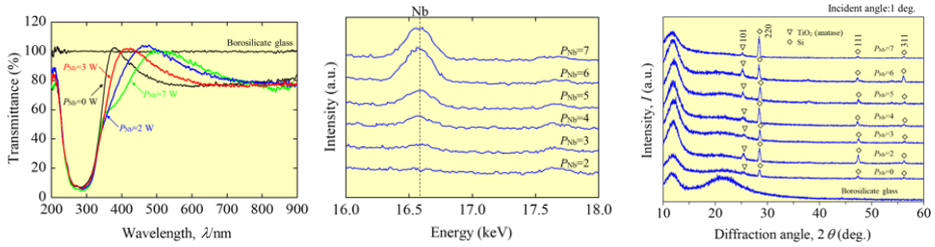


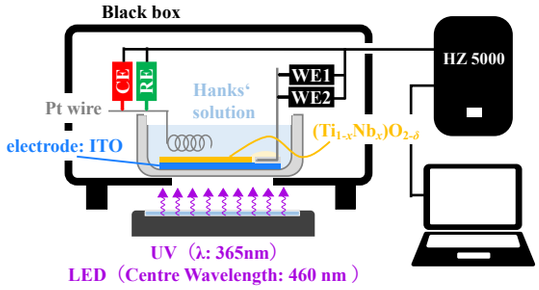
Characterization of $(Ti_{1-x}Nb_x)O_{2-\delta}$

○Sputtering Conditions

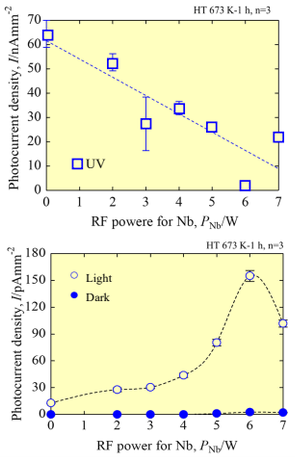
Target : CP Ti
(ASTM 2nd grade,1 inch)
Pure Nb(99.9%)
Power : P_{Ti} 20W, P_{Nb} 0-7W
Atmosphere : Ar : O_2 = 8 : 5
Time : 24h







The photocurrents were drastically decreased compared with those under the UV light. Under the light irradiation by the LED, however, the Nb doped TiO_2 improved the response.



Summary

1. Nb doped TiO_2 films with anatase-type structure could be homogeneously deposited on borosilicate glasses by a conventional co-sputtering with pure Ti and pure Nb targets. The amount of dopant can be easily controlled by changing the input power to Nb.
2. Obvious peak shift could be confirmed to appear in the XRD profiles. It indicated Nb was introduced substitutionary in TiO_2 lattice.
3. In Nb doped TiO_2 films; the photo-response was insensitive to UV, but sensitive to LED compared with those of TiO_2.

Reference

[1] Seeger S. et al. Thin Solid Films 2016; 605: 44–52.
[2] Hung K.H. et al. J. Alloys and Compounds 2011; 509: 10190-10194.