Effect of Erbium doping on photocatalytic reaction of TiO$_2$ under visible light irradiation

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[Introduction]
Organic pollutants in water and air, have become a very serious problem around the world. Photocatalysis is one of the promising friendly technique to solve this problem. TiO$_2$ is the best candidate because of its strong oxidation capability, photostability and low cost. However, the rapid electron-hole pair recombination and poor visible light absorption are problems to be solved.\(^1\,2\) We have synthesized Er-doped TiO$_2$ nanostructures to solve the above problems and investigated photocatalytic efficiency in visible light irradiation.\(^3\)

[Experimental procedure]
Titanium tetraisopropoxide (TTIP, 0.5 M) was dissolved in 70 mL of 1-butanol. 0.005 M (1 %) of Erbium nitrate in 20 mL of water was added slowly to the solution and stirred for 1 h. The pale pink-colored reaction mixture was transferred to a 100 mL Teflon-lined stainless steel autoclave and solvothermal growth was carried out at 150 °C for 25 h. The resulting product was dried and annealed at 350 °C. To estimate the photocatalytic efficiency, the catalyst (75 mg) was suspended in 50 mL of Rhodamine B (10 ppm) solution and stirred for 45 min in the dark. The absorbance of the solution irradiated with a visible light source was measured at constant time intervals.

[Result and Discussion]
Fig 1 (a) shows the XRD patterns of TiO$_2$ and TiO$_2$:1.0Er. The peaks were well matched with anatase phase Titania (JCPDS No. 21-1272). UV-Vis results (Fig 1 (b)) showed that the absorption edge of TiO$_2$ slightly shifted towards visible light region because of Er doping. The Er-doped TiO$_2$ catalyst had characteristic Er absorptions located at 490, 523, and 654 eV which corresponded to the transition of 4f electron from $^4$I$_{15/2}$ to $^4$F$_{7/2}$, $^2$H$_{11/2}$, and $^4$F$_{9/2}$, respectively. The photocatalytic degradation (Fig 1 (c)) results showed the higher photocatalytic efficiency of TiO$_2$:Er compared with pure TiO$_2$. The higher photoactivity under visible light might be attributed to the transitions of 4f electron of Er$^{3+}$ and red-shift in the optical absorption edge of TiO$_2$ by Er doping.

Fig.1: (a) XRD patterns, (b) UV-Vis absorption spectra, and (c) dye degradation curves of pure TiO$_2$ and TiO$_2$:1.0Er.

References