Solvothermal synthesis of photocatalytic TiO_2 nanoparticles in toluene

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Nowadays as the concerns with global environmental issue increase, the application of TiO_2 to the treatment of polluted air and wastewater has become more and more widespread because of its promising photocatalytic performance [1-3]. The photocatalytic activity of TiO_2 is greatly influenced by its crystal structure, particle size, surface area and porosity. With the decrease in particle size of powder to the nanometer scale, the catalytic activity is enhanced because the optical band gap is widened due to the quantum size effect, combined with the increased surface area.

A solvothermal synthetic method to TiO_2 nanoparticles has been investigated in toluene solutions with titanium isopropoxide(TIP) as precursor. Different weight ratios of precursor to solvent were prepared in the mixture. At the weight ratio of 10:100, 20:100 and 30:100, TiO_2 nanocrystalline particles were obtained after synthesis at 250°C for 3 hrs in an autoclave. X-ray diffraction and transmission electron microscopy showed that the product had uniform anatase structure with average particle size below 20nm. As the composition of TIP in the solution increases, the particle size of TiO_2 powder tends to increase. At 5:100 and 40:100, however, pale yellow colloidal solution was obtained without precipitation after synthesis and crystalline phase of TiO_2 was not produced. The specific surface area of the TiO_2 nanocrystalline powder was also investigated using BET surface area analyzer. (Fig. 1-2)

Surfactant aided solvothermal synthetic method in toluene solutions was also investigated to synthesize narrow-dispersed anatase TiO_2 nanoparticles. Weight ratios of precursor to solvent and precursor to surfactant (oleic acid) in the mixture were varied. Low dispersed TiO_2 nanocrystalline particles with average size <6 nm were synthesized after thermal treatment at 250°C for 20 hrs in an autoclave. (Fig. 3) Size distribution of particles synthesized is narrower than particles synthesized without surfactant. [4] High intensity of ring pattern corresponding to (004) plane in the SAD image strongly implies that nanorods orient preferentially along [001] axis. (Fig. 4)

Anatase nanorods can be obtained from the solution with precursor:surfactant molar ratio of more than 1:3 for precursor:solvent weight ratio of 10:100 and the solution with precursor:solvent weight ratio of more than 20:100 for precursor:surfactant molar ratio of 1:3.

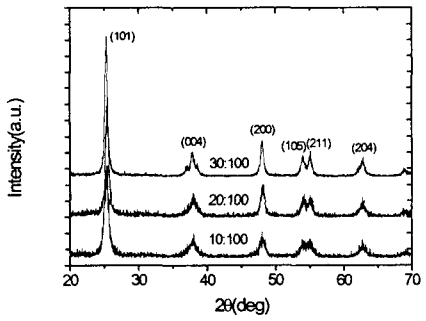

Fig. 1

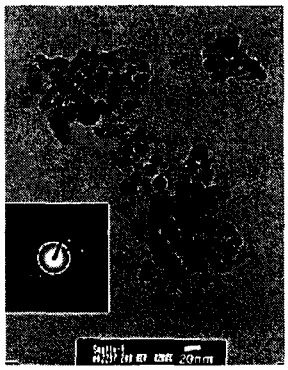

Fig. 2

Fig. 3

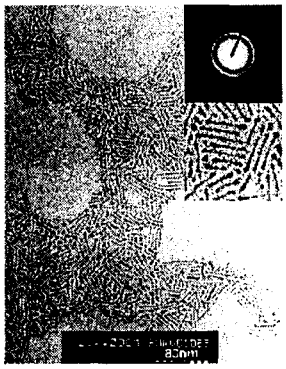

Fig. 4

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