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Anatase rutile transformation temperature

Difference between rutile and anatase tio2. What is anatase and rutile. Anatase to rutile transition temperature.

The role of tin doping on the photocatalytic activity of titanium dioxide (TiO2) nanomaterials was investigated using different concentrations of Sn (1, 2.5, 5, 10, and 15 at%). The synthesized samples were characterized by various techniques such as XRD, TG, DTA, EDS, XPS, DRS, SEM, BET, and PL. The degradation of rhodamine B in aqueous solution under UV light was used to assess the photocatalytic activity. The results showed that doping with Sn promotes phase transformation from anatase to rutile and influences the heat treatment temperature and Sn concentration on photocatalytic activity. A higher degradation rate was observed at 350°C for 1% Sn–TiO2, while a better performance was achieved at 500°C and 650°C for 5% Sn–TiO2. With increasing annealing temperature, the anatase/rutile phase transition temperature is significantly influenced by ion doping, particularly with elements such as Nd, La, Fe, etc. On one hand, doping these ions raises the temperature, whereas Sn doping reduces it and promotes the transition from anatase to rutile. Alves et al. reported that pure TiO2 exhibited excellent photocatalytic activity after annealing at 650 °C, but 0.5 wt% Sn-doped TiO2 showed higher efficiency despite having a higher percentage of rutile. Given this background, both the heat treatment temperature and doping concentration have crucial impacts on the crystal structure and photocatalytic activity of TiO2, leading to a systematic study of pure and Sn-doped TiO2 nanomaterials with varying amounts of Sn4+ ions synthesized via a sol-gel method. The researchers used a high-pressure mercury lamp to degrade Rhodamine B (RhB) and measured its absorbance at 553 nm to track the degradation rate. They also analyzed the crystal structure and size of titanium dioxide (TiO2) nanomaterials with different levels of tin doping, annealed at various temperatures. The X-ray diffraction (XRD) patterns showed that all samples had a similar anatase structure at 350°C, but as the temperature increased to 500°C, pure TiO2 became more crystalline. The addition of tin up to 1% didn't change this pattern, but higher concentrations (>2.5%) led to the appearance of rutile peaks and the formation of SnO2. At 650°C, both anatase and rutile structures were present in pure TiO2, indicating a phase transition from anatase to rutile. In contrast, Sn-doped samples showed reduced or absent anatase peaks at high tin concentrations, suggesting that the addition of tin affected the crystal structure and size. The researchers calculated the average crystallite size using XRD data and found that pure TiO2 crystals grew larger with increasing temperature, while Sn-doped samples had smaller crystals. The mass fraction of anatase was also determined, showing that the addition of tin reduced the amount of anatase present in the samples. 25.8/36.9: 1% Sn–TiO2 Anatase (18.2 wt%)/rutile (81.8 wt%) 27.0/42.3: 2.5% Sn–TiO2 Rutile 35.9: 5% Sn–TiO2 Anatase (6.8 wt%)/rutile (93.2 wt%) 23.7/34.0: 10% Sn–TiO2 Rutile 28.5: 15% Sn–TiO2 Rutile 26.5 As seen in Table 1, the percentage of rutile increases with rising Sn content, suggesting that Sn doping promotes the transition from anatase to rutile and lowers the phase transformation temperature. There are several explanations for this phenomenon. Some researchers believe that higher surface energy benefits the phase transformation, as smaller anatase particles have higher surface energy and area, making it easier to start the transformation. However, this viewpoint is still disputed. The addition of elements like La28 or Ce32 in TiO2 always results in a reduction of crystallite size but inhibits the phase transformation and increases the transition temperature. Other researchers believe that the melting point of MXOY (M being the doping element) plays a key role in the anatase-rutile phase transformation, with the transformation being promoted if the melting point is lower than TiO2's (1640 °C) and restrained if it is higher. The melting point of SnO2 is 1127 °C, much lower than TiO2, which supports the promotion of the phase transformation. Additionally, some researchers suggest that the phase structure of SnO2 is similar to rutile, favoring the formation of the rutile phase during the transition. In this study, we believe that the relatively low melting point of SnO2 and the structural similarity between SnO2 and TiO2 make it propitious for the transition from anatase to rutile. There has been significant research demonstrating that TiO2 with an anatase structure or mixed anatase-rutile structure exhibits excellent photocatalytic activity. From this discussion, both the heat treatment temperature and Sn doping content affect the phase structure and further affect the photocatalytic activity of TiO2. This provides a feasible method to regulate the phase structure and obtain better photocatalytic activity for TiO2 by combining a proper heat treatment temperature and doping amount. Researchers studied the effects of tin doping on titanium dioxide (TiO2) and its photocatalytic properties. When pure TiO2 was heated to approximately 581°C, it underwent an exothermic reaction, which could be attributed to both the combustion of organic compounds and a phase transition from anatase to rutile. However, when 10% Sn-TiO2 was heated to around 481°C, the phase transformation temperature decreased significantly, suggesting that Sn doping can accelerate this process. X-ray diffraction (XRD) analysis confirmed the presence of Sn in the TiO2 sample. Energy-dispersive spectroscopy (EDS) and X-ray photoelectron spectroscopy (XPS) further revealed the chemical composition of 5% Sn-TiO2, indicating that Sn is incorporated into the TiO2 lattice via doping. The researchers found that Sn addition promotes the phase transformation from anatase to rutile and increases the surface hydroxyl groups on the TiO2 surface. This increase in surface hydroxyl groups enhances the photocatalytic process. However, the effect of Sn doping on the optical properties of TiO2 is controversial. Some studies have reported a red shift in the band gap energy, while others have observed a blue shift. The researchers used diffuse reflectance spectroscopy (DRS) to investigate this issue and found that the band gap energy of 5% Sn-TiO2 was slightly higher than that of pure TiO2. Overall, the study suggests that Sn doping can enhance the photocatalytic properties of TiO2 by accelerating the phase transformation and increasing surface hydroxyl groups. The study investigated the effects of Sn-doping on TiO2, focusing on its optical properties and surface area. The results showed that Sn-doped TiO2 exhibits a blue shift in its band gap energy compared to pure TiO2, indicating an improvement in its photocatalytic activity. This blue shift was attributed to the substitution of Ti4+ ions with Sn4+ ions in the TiO2 lattice, which alters the electronic structure and creates new energy levels. The study also analyzed the surface area of the samples using BET theory and found that the surface area increases significantly after adding Sn. The highest surface area was observed for the 15% Sn-doped sample, indicating its potential for enhanced photocatalytic activity. In addition, photoluminescence (PL) analysis revealed that the intensity of the emission spectra decreases with increasing Sn concentration up to 5%, suggesting improved separation and recombination of photogenerated pairs. However, further increase in Sn doping content leads to an increase in the PL spectrum intensity, indicating increased recombination of photogenerated pairs. The study's findings are consistent with previous research by Bhange et al., who attributed the decrease in PL intensity at high Sn doping levels to the formation of SnO2. Key points: * Sn-doped TiO2 exhibits a blue shift in its band gap energy compared to pure TiO2. * The surface area of Sn-doped samples increases significantly with increasing Sn concentration. * Photoluminescence analysis shows improved separation and recombination of photogenerated pairs up to 5% Sn doping, but increased recombination at higher Sn concentrations. * Formation of SnO2 may contribute to the decrease in PL intensity at high Sn doping levels. The addition of Sn to TiO2 enhances its photocatalytic activity. When heated to 350 °C, the pure TiO2 showed low degradation rates, whereas the Sn-doped samples demonstrated significant improvements in decomposition rates of RhB solution. The 1% Sn–TiO2 sample annealed at 500 °C displayed a degradation rate of 92.8%, surpassing that of pure TiO2 by over two times. This boost in activity was attributed to the rise in crystallinity with increasing temperature and the creation of more surface defects due to Sn doping, which facilitated the capture of photogenerated electrons and suppressed recombination. The presence of Sn also led to the formation of surface hydroxyl groups, enhancing the adsorption and hydration abilities of RhB molecules. Furthermore, the XRD results revealed that rutile TiO2 formed in samples with higher Sn concentrations, promoting electron transfer and prolonging the lifetime of photogenerated pairs. The degradation rates of different TiO2 samples with varying Sn content were measured after heat treatment at 650 °C. The results showed that all samples had lower photocatalytic activity than those treated at 500 °C, due to high rutile content. Rutile TiO2 exhibits lower photocatalytic activity because it has poor hydroxylation and oxygen absorption properties. The kinetics of the photocatalytic degradation of RhB were found to follow a first-order model, with the reaction rate constant (k) being higher for samples with more Sn doping. The addition of Sn significantly improved the photocatalytic activity of TiO2, especially at lower heat treatment temperatures. The study used various analytical techniques to characterize the properties of the synthesized TiO2 nanomaterials. The results showed that all samples formed anatase at 350 °C, while higher temperatures led to the formation of rutile in Sn-doped samples. The presence of Sn promoted the phase transformation from anatase to rutile. The photocatalytic activity was found to be affected by both the heat treatment temperature and Sn content. Samples with 1% Sn at 350 °C showed the highest degradation rate, while those with 5% Sn at 500 °C and 650 °C had higher degradation rates than pure TiO2. Overall, the study demonstrates that the addition of Sn significantly improves the photocatalytic activity of TiO2, especially when heat-treated at lower temperatures. A collection of research articles from various journals has been compiled, highlighting studies on materials science and related fields. The papers cover a range of topics, including surface science, coatings, ceramics, catalysis, and more. Some specific findings include: * Researchers have explored the properties of various materials, such as nanoparticles, thin films, and composites. * Studies have investigated the effects of different parameters, like temperature, pH, and pressure, on material behavior. * New methods for synthesizing and characterizing materials have been developed and tested. * The potential applications of these materials in fields like energy, environment, and healthcare have been examined. Notable authors and their contributions include: * O. Bechambi et al., who published a paper on the application of surface science principles to understand material behavior. * H.B. Jiang et al., who investigated the catalytic properties of certain materials. * Y. Zhang et al., who developed new methods for characterizing ceramic materials. The compilation provides an overview of recent research in these fields, showcasing the diversity and complexity of materials science studies. A series of studies investigated the properties and applications of various materials in energy-related fields. Research by Ma et al. (1994) explored material characteristics, while Kumar et al. (2007) focused on scripta material properties. Mehraz et al. (2017) examined solar energy materials, and Huang et al. (2009) studied solid-state chemistry. Duan et al. (2013) investigated electrochemical phenomena, Zhang and Yates (2012) analyzed chemical reactions, and Dozzi et al. (2014) explored catalytic processes. Other studies by Oropeza et al. (2011), Kadam et al. (2017), Erjavec et al. (2015), Carp et al. (2004), Ali et al. (2016) and their colleagues contributed to the understanding of material properties in various contexts.