Alignment of micron-sized TiO_2 particles as a platform for highly efficient photocatalytic reaction

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Generally, aggregates of oxide semiconductor particles which possess high surface/volume ratio have been used for photocatalytic reactions. However, because many defects were randomly included, the reaction efficiency is lowered due to the recombination of electrons and holes generated by light irradiation. Then, less defect substrates are expected, while maintaining the large surface area. Also, the separation of electrons and holes is the key requirement for high efficiency. We aimed to make optimal reaction sites for the charge separation by the alignment of Janus particles (TiO_2/Pt) on the substrate. As a first step, we tried various methods to align TiO_2 particles on a glass with a photoresist structure which was fabricated by photolithography.

We coated the negative photoresist (mr-DWL 5, micro resist technology) on a glass and irradiated the patterned UV light, and was developed to get the structure. The shape was consisted of straight-line channels that were 7 μm in width and 6 μm in depth. This size was optimized for the diameter of the TiO_2 particles. We prepared a liquid cell by sandwiching this substrate and another glass with a spacer film and injected a suspension solution of TiO_2 particles that was 6 μm in diameter (SicastarTiO_2, Micromod) into the cell and dried it.

Fig. 1 shows the alignment of TiO_2 particles in the photoresist structure before drying the solvent. We could observe the alignment of TiO_2 particles in a line. It is because TiO_2 particles were pulled into the photoresist structure by capillary force. After drying the solution (60 min), TiO_2 particles were still aligned on the glass after removal of the solvent as shown in Fig. 2. Furthermore, this image suggests that TiO_2 particles were packed by the photoresist structure. From this result, it is assumed that attractive interaction among TiO_2, the resist and the glass affects the alignment of TiO_2 particles. Furthermore, we could align the Pt/TiO_2 Janus particles using this method.

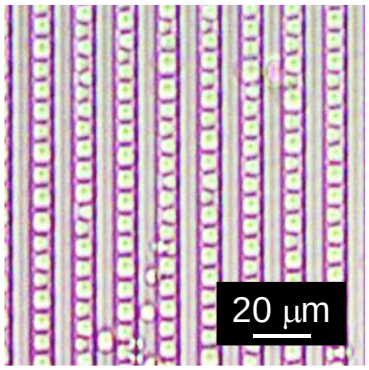

Figure 1. Alignment of TiO_2 particles in a suspension solution in the photoresist structure

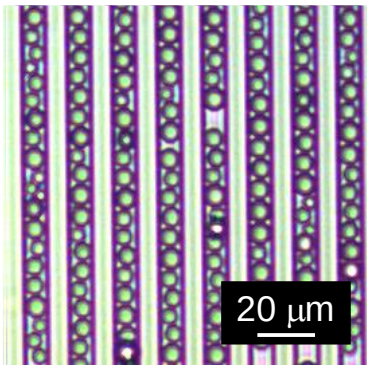

Figure 2. Alignment of TiO_2 particles after drying

Funding: JSPS KAKENHI Grant (#15K05549, and # 15K17879), Grant for Basic Science Research Projects from The Sumitomo Foundation, and Institute of Science and Engineering, Chuo University, and JST, PRESTO.

References:

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