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Short communication

# Light-driven high-temperature continuous-flow synthesis of $TiO_2$ nano-anatase

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## HIGHLIGHTS

- ► A fundamentally new reactor strategy for nanomaterial synthesis is reported.
- ► The key is conflating unorthodox optics with spinning disk processors.
- ► Experimental results and structural characterization are for $TiO_2$ nano-anatase.
- ► We depict a continuous-flow high-temperature strategy for nanomaterial generation.

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## ABSTRACT

Developing continuous-flow high-temperature fabrication strategies constitutes a pivotal challenge in the realization and scale-up of some functional nanomaterials. We have developed a light-driven large-area spinning-disk processor for this purpose, and establish its continuous-flow capability in preparing $TiO_2$ anatase-phase nanoparticles with reaction temperatures up to 550 °C. This reactor strategy markedly reduces reaction time – primarily by eliminating the need for product calcination – while maintaining high conversion efficiency.



## 1. Introduction

The interest in titanium dioxide ($TiO_2$) nano-anatase derives in part from its exceptional photocatalytic activity, with established applications in disinfection [1], dye-sensitized solar cells [2] and promoting photosynthesis [3]. The focus in this paper is on the synthesis of $TiO_2$ anatase-phase nanostructures by a high-temperature, continuous-flow (rather than batch) spinning-disk processing procedure. Current synthetic procedures for anatase commonly suffer from the need for calcination in order to extract the $TiO_2$ nanostructures, which is a requirement eliminated by the method reported herein. Moreover, the use of batch processing in general for nanoparticle synthesis can suffer from uneven mixing and anisotropic heat transfer [4].

The spinning disk processor (SDP) has proven effective in chemical syntheses that do not require temperatures above ~200 °C. It consists of a rapidly rotating disk surrounded by a cooled reactor wall, and exploits centrifugal force to generate thin liquid films (typically less than 200 μm), resulting in high and controllable rates of heat and mass transfer [5–8] (Fig. 1a and b). Reactants are introduced near the center of the spinning disk, and the reaction takes place over the disk's surface. The product is collected from the cooled reactor wall, where rapid quenching of the products allows control of process termination, thereby improving selectivity.

A key virtue of the SDP is the possibility of fine tuning the shape, size and morphology of nanoparticles by varying disk speed, reactant flow rate and concentration, surface texture, and temperature [4,9–11]. The SDP has also been used to control chemical reactivity,

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