Synthesis and crystallization of TiO_2 nanoparticles for application in solar panels

Pedro R. Motta, Lean van Engelen, Dylan Crijns and Sam Castermans, K. Stout, R. van Zandvoort, J. Welzen, P. Buskens

Chemelot Innovation and Learning Labs
ZUYD
Brightlands Materials Center

Introduction

The challenge of the **Flow4Nano** project is to improve the light absorption of solar cells by producing a polymer laminate with a high refractive index using TiO_2 nanoparticles and therefore creating a film which results in the least amount of light scattering.

Goal

Synthesize and crystallize TiO_2 nanoparticles with particle size below 50nm to decrease the light scattering.

Synthesis of amorphous TiO_2 nanoparticles

Method

To synthesize the amorphous nanoparticles a 2L reactor (Figure 1) is used. After the synthesis the dispersion needs to go through purification steps:

- Centrifugation
- Dialysis

Figure 1

Results

To produce the nanoparticles the mixing speed, reactant addition and pH were modified to achieve the best parameters in order to optimize the yield, particle size and polydispersity of the dispersion. For the purification step different process such as filtration, centrifugation and dialysis were tested to check which would be efficient and at the same time practical.

DLS measure before purification process

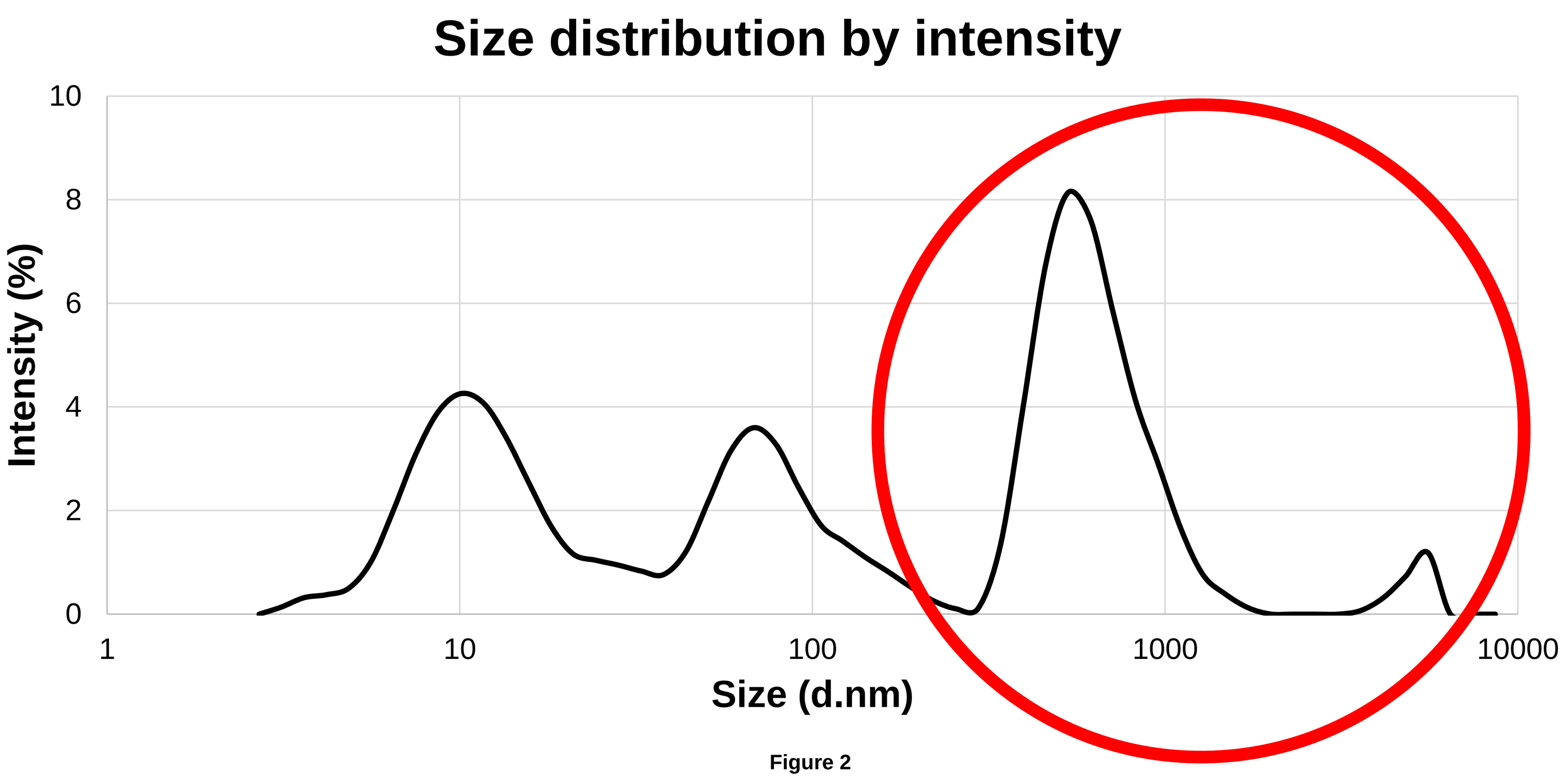

Figure 2

DLS measure after purification process

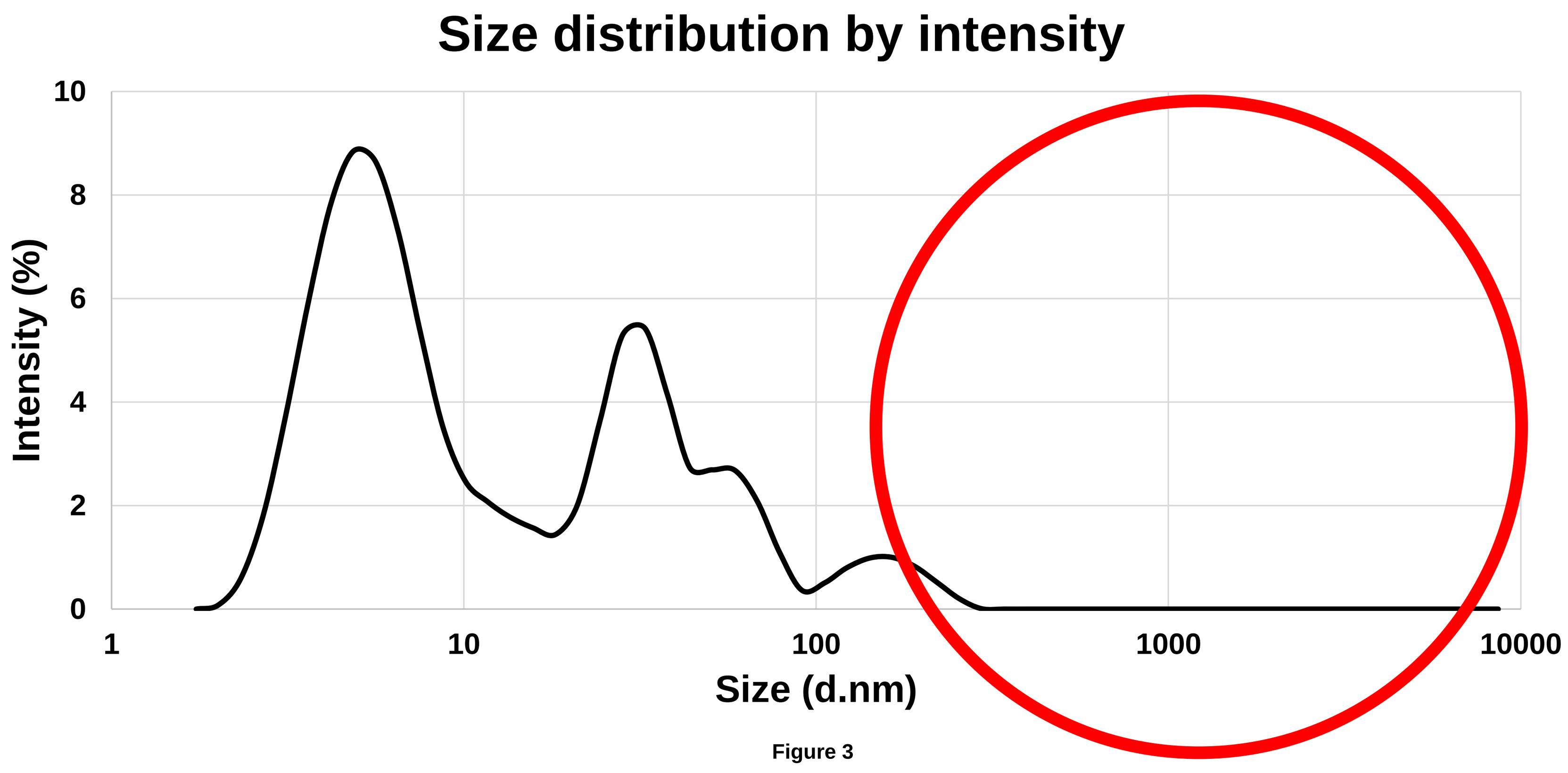

Figure 3

The synthesis yield is around 87% and it can be consistently achieved even after several modification to optimize the process.

Crystallization in the micro flow reactor

Method

The titanium dioxide is crystallized in a micro flow reactor because it has several advantages of the flow process over the batch process such as easier to scale up, more productive, better control over the parameters, etc.

Different parameters such as temperature, pH, pressure and residence time can influence the particle size, polydispersity and crystallinity of the nanoparticles.

Results

Crystalline particles below 100 nm can be produced even without any purification using different settings.

XRD spectra of crystalline TiO_2 nanopaticles

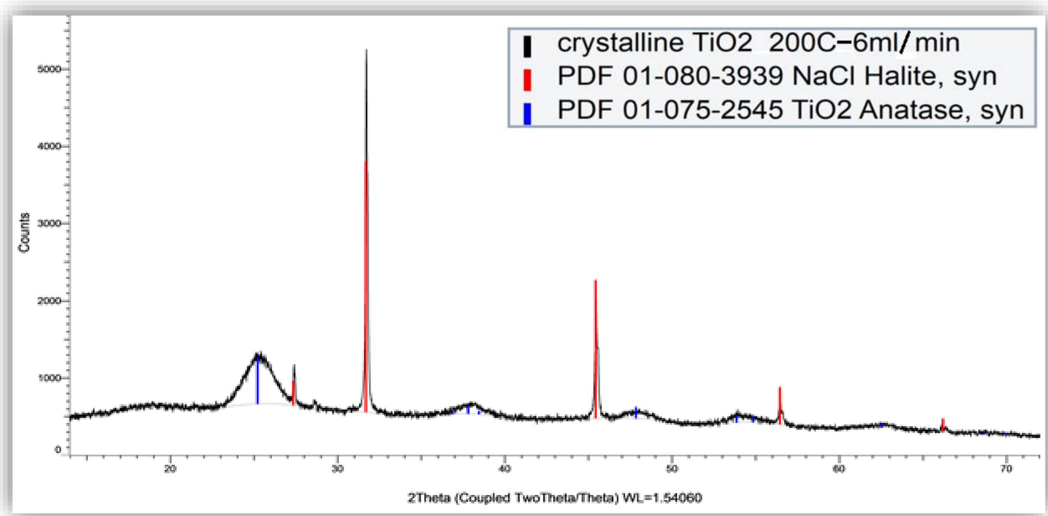

Figure 4

SEM image of crystalline TiO_2 nanoparticles

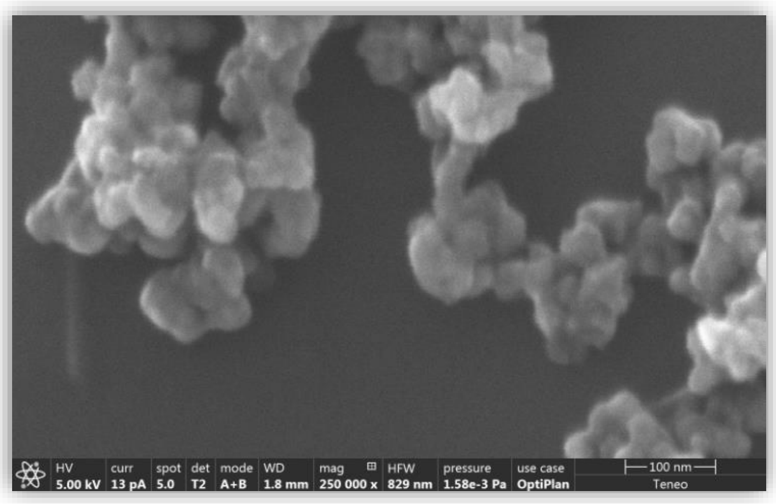

Figure 5

DLS measure after crystallization at 200°C, 10 min residence time

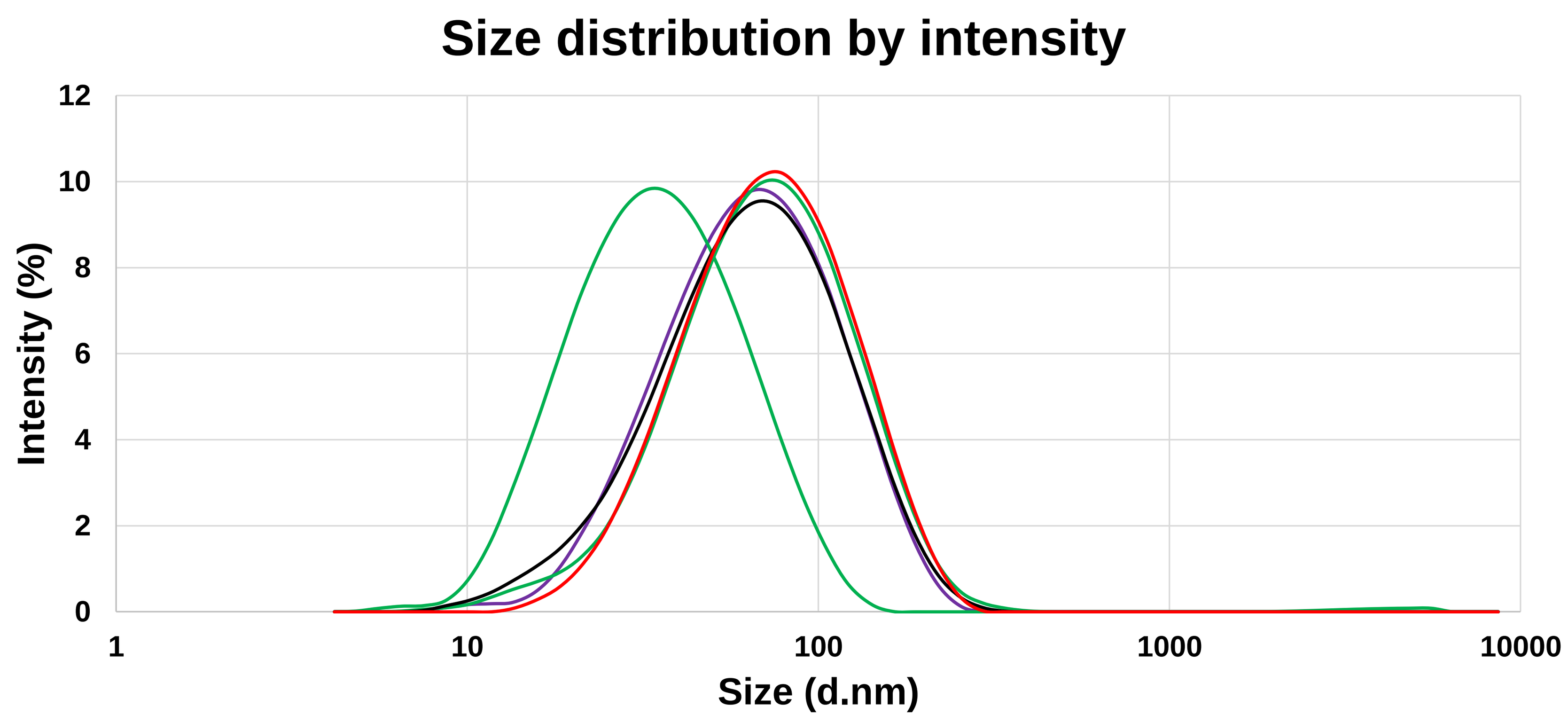

Figure 6

Conclusion

Crystalline TiO_2 nanoparticles with less than 100 nm can be produced using the synthesis and crystallization process presented in this project.

Future work

- Up scale the synthesis from 2L to 10L
- Optimize the parameters in order to improve the polydispersity

Contact

- Nome: Ryan van Zandvoort / Kathleen Stout
- E-mail: ryan.vanzandvoort@tno.nl / kathleen.stout@zuyd.nl

The Flow4Nano project is subsidized by SIA

01-02-2019
www.brightlandsmaterialcenter.com