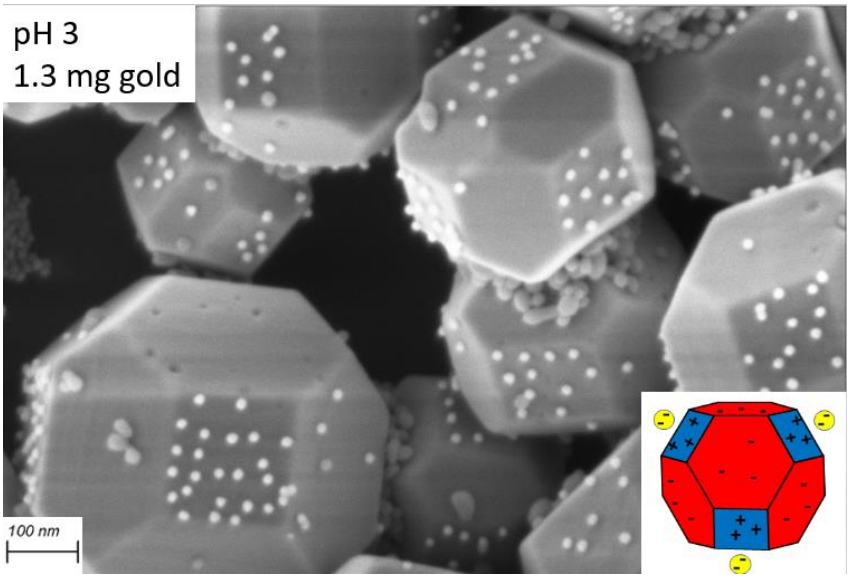
Bachelor thesis project: Facet-selective colloidal deposition



BACKGROUND

Faceted $SrTiO_3$ particles are well-known for their photocatalytic properties, converting the energy of UV light to hydrogen and oxygen. However the efficiency of this electrochemical reaction needs to be strongly improved in order to make it commercially viable. One 'mystery to be solved' concerns the small co-catalyst particles, which are needed to enhance the reactions. It has been hypothesized that coating the 110 and 100 facets of $SrTiO_3$, each with the right type of co-catalyst, would strongly improve the catalytic efficiency. Recent work in the PCF group has shown that at the pH where the different $SrTiO_3$ facets carry opposite charges, selective cocatalyst assembly can be achieved (see picture[1]). However because the (SEM) observations were only made after drying, the details of the assembly and the achievable level of control remain unclear.

Using fluorescently labeled colloidal nanoparticles, the mechanism of the facet-selective assembly could also be studied with a confocal optical microscope (CSLM). While the lateral resolution will not be as good as with SEM, CSLM offers the unique advantages of measuring time-resolved and inside the fluid. Since this has never been applied to $SrTiO_3$ / cocatalyst systems, the BSc project will offer both novelty and challenges.

RESEARCH OBJECTIVES

The first goal is to visualize tiny (25 nm) fluorescent colloidal polystyrene particles as they adsorb onto the $SrTiO_3$ particles. The free 'cocatalyst' colloids will diffuse too fast to be detected, but adsorption will drastically slow them down. The electrostatically driven adsorption should be enabled by setting the optimal pH. In a next phase, stationary (e.g. gravity-settled) $SrTiO_3$ particles are used to obtain more detailed information: the dynamics (including reversibility) of the adsorption can be studied by tracking over time and adjusting the pH *in situ*, and if the particles are large enough, the facets can be identified. Image analysis should reveal how precisely the amount of adsorbed 'co-catalyst' can be measured. These experiments can be complemented with SEM and zeta-potential (service) measurements.

LEARNING OBJECTIVES

In addition to the standard learning objectives for a Bachelor's project (research planning, academic writing, data presenting, how to work in a lab environment, etc.), you will:

- Acquire or increase your lab experience with colloids
- Learn how to work with a confocal scanning laser microscope
- (Co-) develop some image analysis to quantify the (time-dependent) adsorption

CONTACT INFORMATION

Dr. Michel Duits (daily advisor)
Prof. Frieder Mugele (MSc thesis supervisor)

REFERENCE

1. Berwout Heemstra, MSc thesis, University of Twente, PCF group, 2022.