Bifunctional Nanoparticles for Photocatalytic Reactions

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1 Introduction and Purpose

In the Project we are using Silver and Gold nanoparticles surrounded by a Titania shell for the photocatalytic reduction of methylene blue (MB). These Ag/ TiO_2 (or Au/ TiO_2) core shell nanoparticles were sythesised in the collaborating University of Osnabrueck. The advantage of the core shell nanoparticles compared with pure Titania NP is the plasmon resonance shift. This allows to illuminate the sample in the visible range. The purpose of this project is to measure the photocatalytic activity of the two bifunctional core shell nanoparticles in colloidal suspension in the UV and Vis range compared with Titania. To determine the photocatalytic activity we use methylene blue, because after the reaction the colour changes from blue to colourless.

2 Experiment and Results

In figure 1 is shown a picture of the Au/ TiO_2 NP measured with high resolution transmission electron microscope (HRTEM). The gold NP are surround by a closed shell, which is supposed to be amorphous Titania. This has to be proved with a scanning transmission electron microscope, with which an analysis of the elements is possible.
The first measurements were about proving the photocatalytic activity of the core shell nanoparticles in the UV range. Therefore we built up a setup,

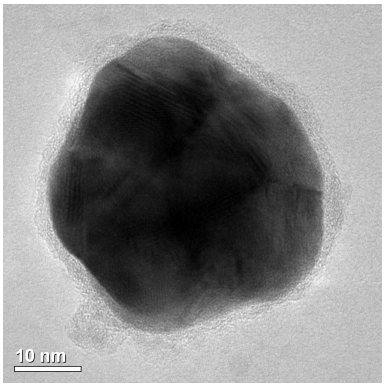

Figure 1: HRTEM picture of Au/ TiO_2.

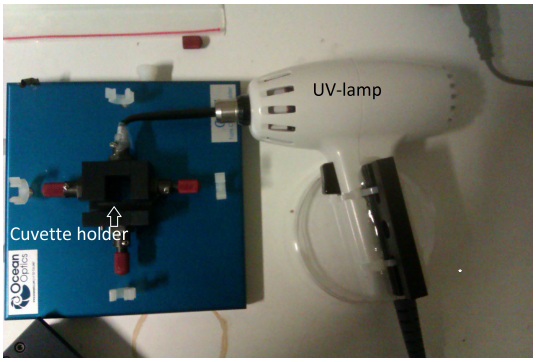

Figure 2: Experimental setup of UV range measurements in a cuvette.

which is shown figure 2. We have diluted the NP suspension with ethanol and have added afterwards the methtylene blue, that the final concentration of the solution was mM. With a UV/ Vis spectrometer we have measured the absorption spectra of the dye. The methylene blue changes the colour from blue to colourless, if the photocatalytic reaction takes place. Hence we can determine the amount of methylene blue, which has reacted, by measuring the absorbance of the dye. In figure 3 and 4 is shown the absorbtion spectra of the suspension of Au/ TiO_2 and Ag/ TiO_2 at different illumination time.

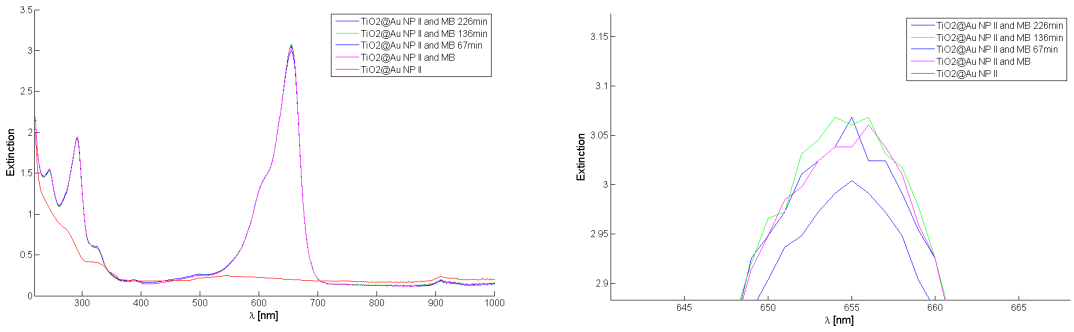

Figure 3: Absorption spectra of methylene blue in a 0.1 mM colloidal suspension of Au/ TiO_2.

The absorption maximum at nm of methylene blue is decreasing with longer

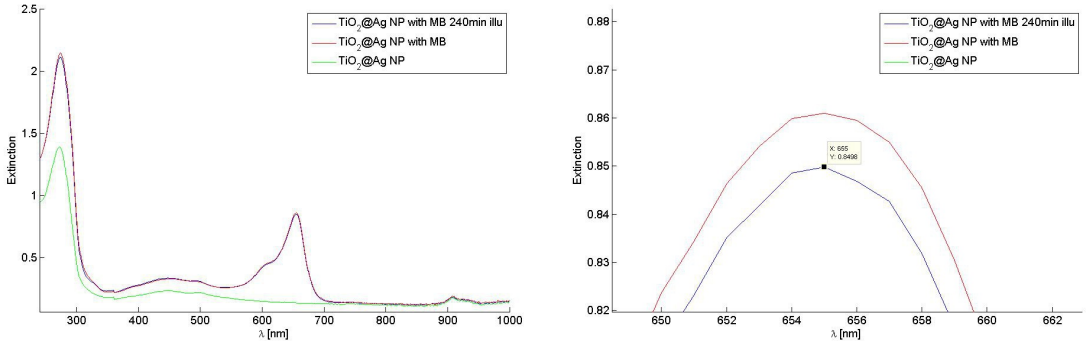

Figure 4: Absorption spectra of methylene blue in a 0.1 mM colloidal suspension of Ag/ TiO_2.

illumination time. This means, that the concentration of methylene blue also decreases from 0.122 mM to 0.120 mM. The photocatalytic activity seems to be relativly low, but therefore we have to compare the results with the results of the Titania NP.
One reason for the low efficiency is the illumination far away of the resonance peak of the NP. Another could be a steric hindrance for the methylene blue to penetrate to the surface of the NP caused by the PVP, which stabilize the particles. To verify this the PVP amount has to the decreased as much as possible without aggregating of the NP.

3 Outlook

In the further measurements we will figure out, if the PVP influences the photocatalytic activity of the NP. Also if the activity increases by illuminating with a laser near the reasonance peak and at least how high the activity is compared to the Titania NP. The STEM characterisation will prove, if the surrounding shell consists of amourphous TiO_2.