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In-line coagulation monitoring of beer haze using spectrally resolved back scattering sensors in beer

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INTRODUCTION

Motivation / Background: Coagulation monitoring plays an important role in quality control and reliability for food production and storing processes. The in-line monitoring of contaminants and slow growing particles simplifies detection of haze formation and facilitates more precise determination of expiry dates. The turbidity and haze formation in beer, for example, affects the quality and stability of the beer. To obtain a better understanding of this formation process two measurement technique will be presented and described here.

Supported by Mie calculations[3] concentration and pH-value influences to the particle growth are shown and validated through light-microscopy reference measurements. Both measurements are working with spectrally resolved back scattering sensors as shown in Fig.1. The two different techniques can be measured using the same probe.

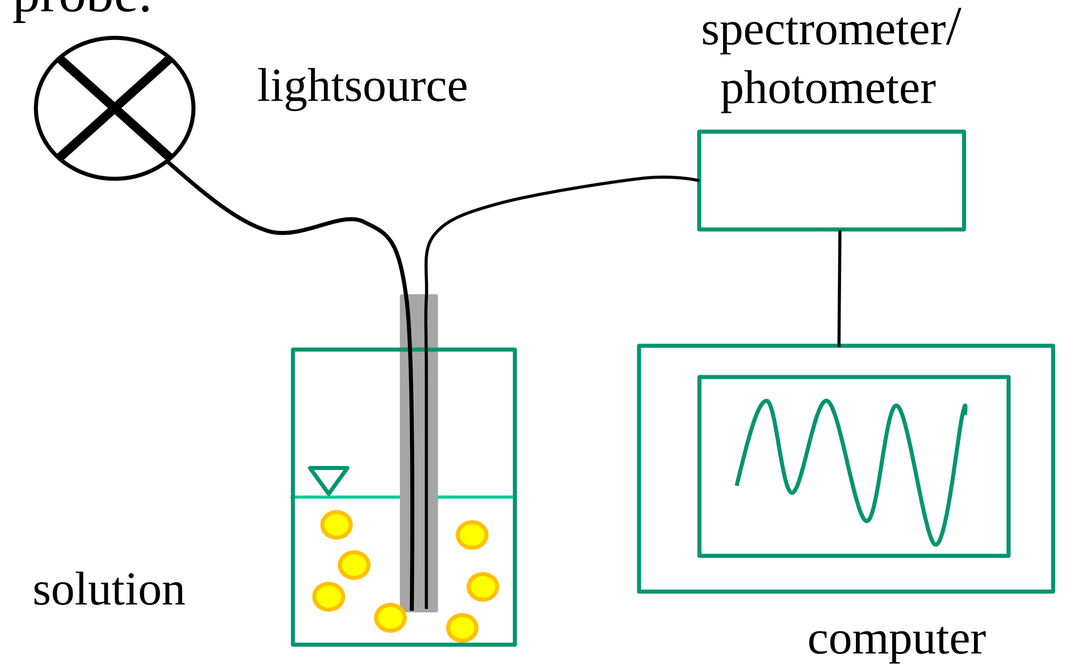

FIG.1: Laboratory setup for back scattered light measurement

MEASUREMENT TECHNIQUE 1

Gluten is used to **analyse protein precipitation** that consists of equal parts glutelin and prolamin amino acids. Both proteins precipitate at a pH-value between 4.2 und 5.2 at the isoelectric point. The sampling rate is 5 hertz. To simulate the average particle size a particle size distribution using microscopic analyses is conducted as shown in Fig.2.

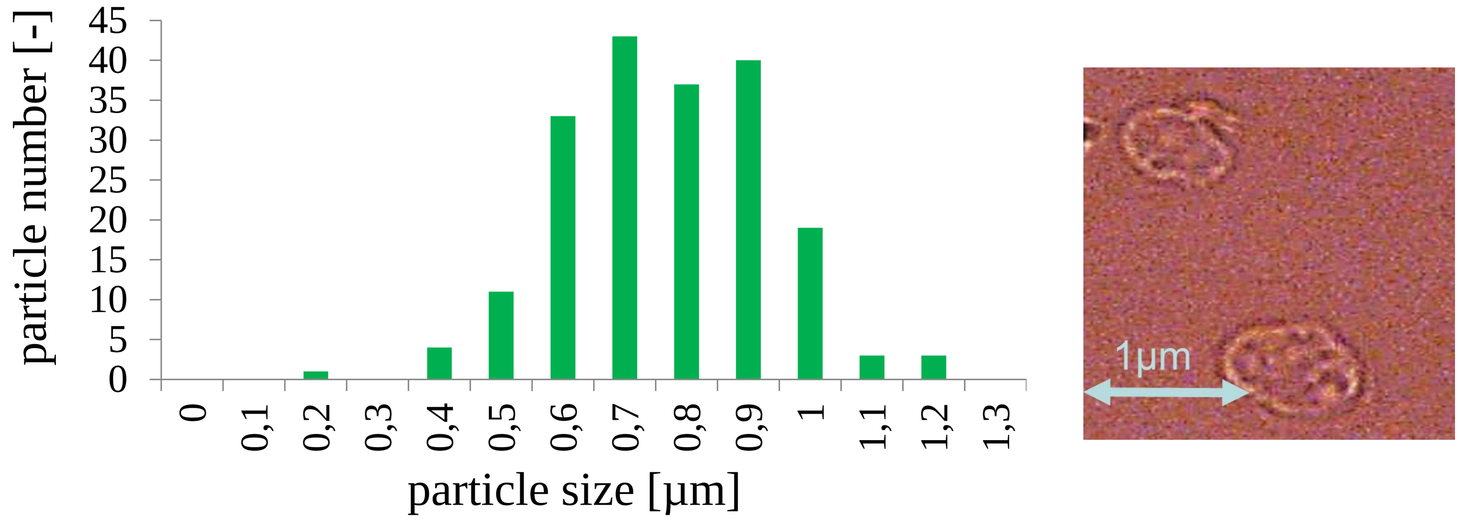

FIG.2: Particle size distribution of precipitated amino acids (left), proteins under a microscope (right)

With the measured size distribution information simulations are done to determine the theoretical average particle size. The simulated particles are between 0.4µm up to 1.2µm in diameter as shown in Fig.2 and 3.

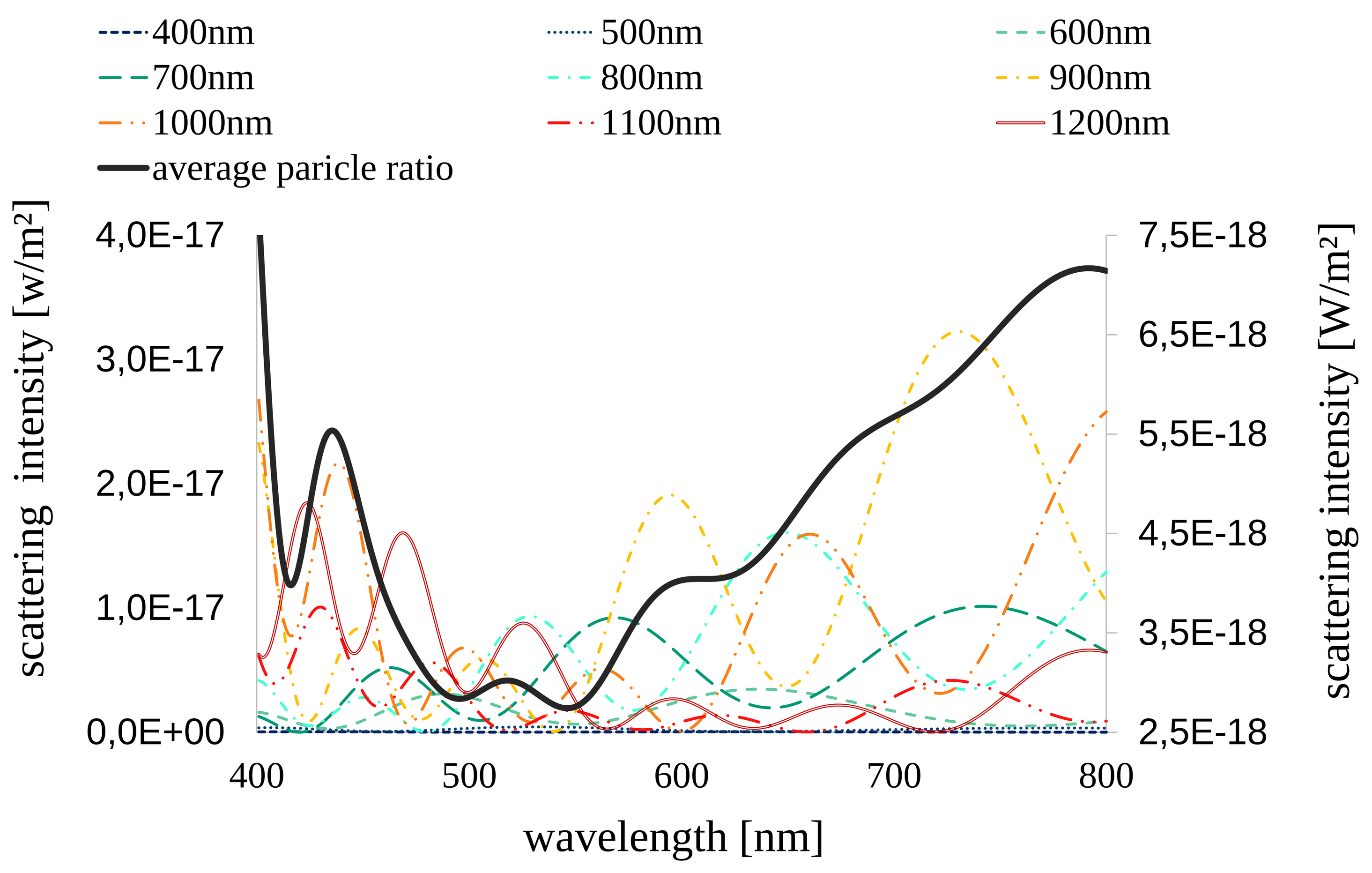

FIG.3: Mie based calculation of back scattered light related to the wavelength

First for each size a one particle system is simulated. Then in relation to the microscopic measurements by adding size weighted particle distribution an average particle diameter can be determined. In a following step the simulated and the back scattered measurement are compared to each other as shown in Fig.4.

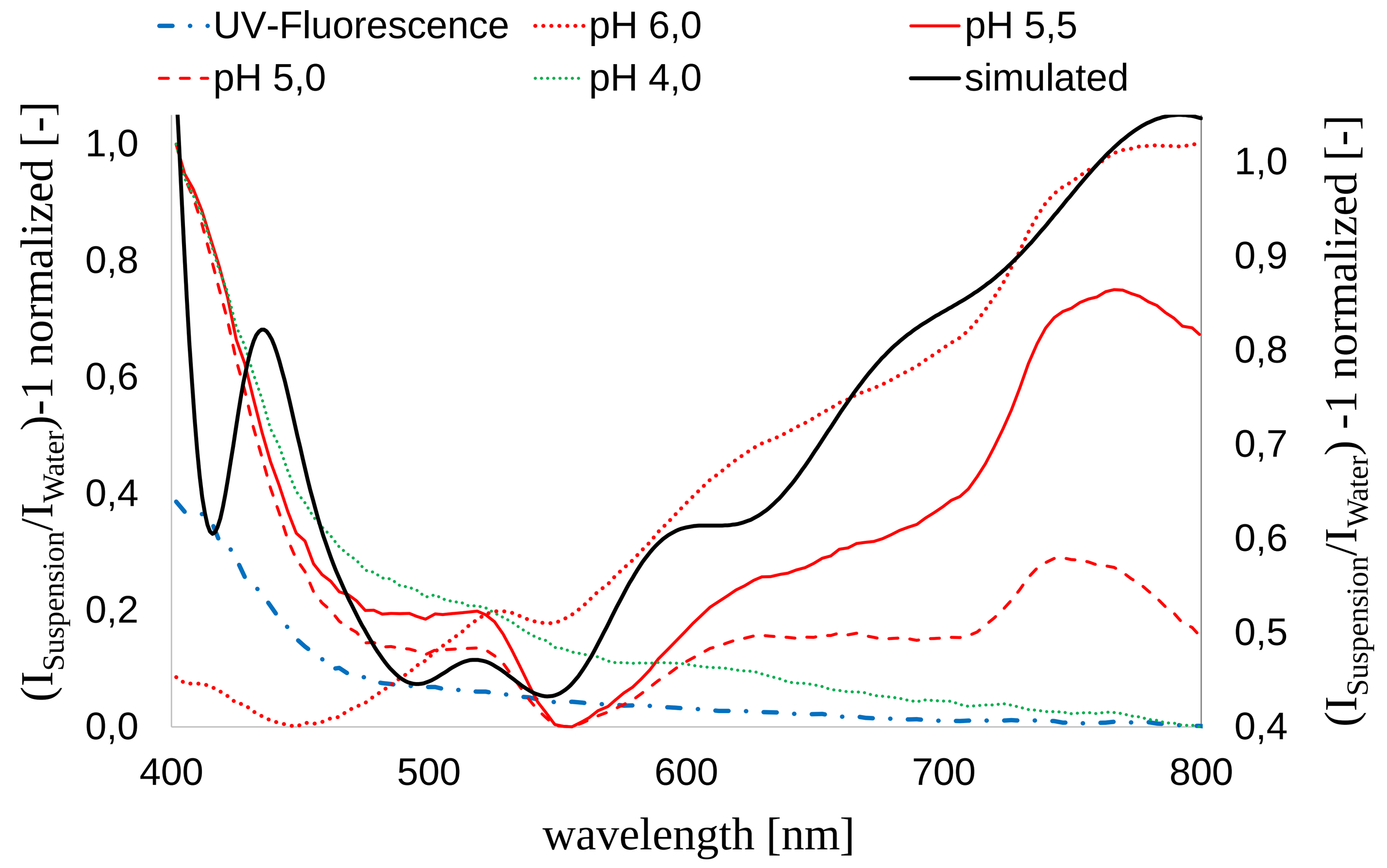

FIG.4: Comparison between measurement and simulation of solved and precipitated gluten

MEASUREMENT TECHNIQUE 2

In a second study **oxalate precipitation is analysed**. This **technology** with 2300 hertz per channel is used with two different wavelengths, 450nm and 650nm, to observe particle growth. Fig.5 compares the simulated and the measured results.

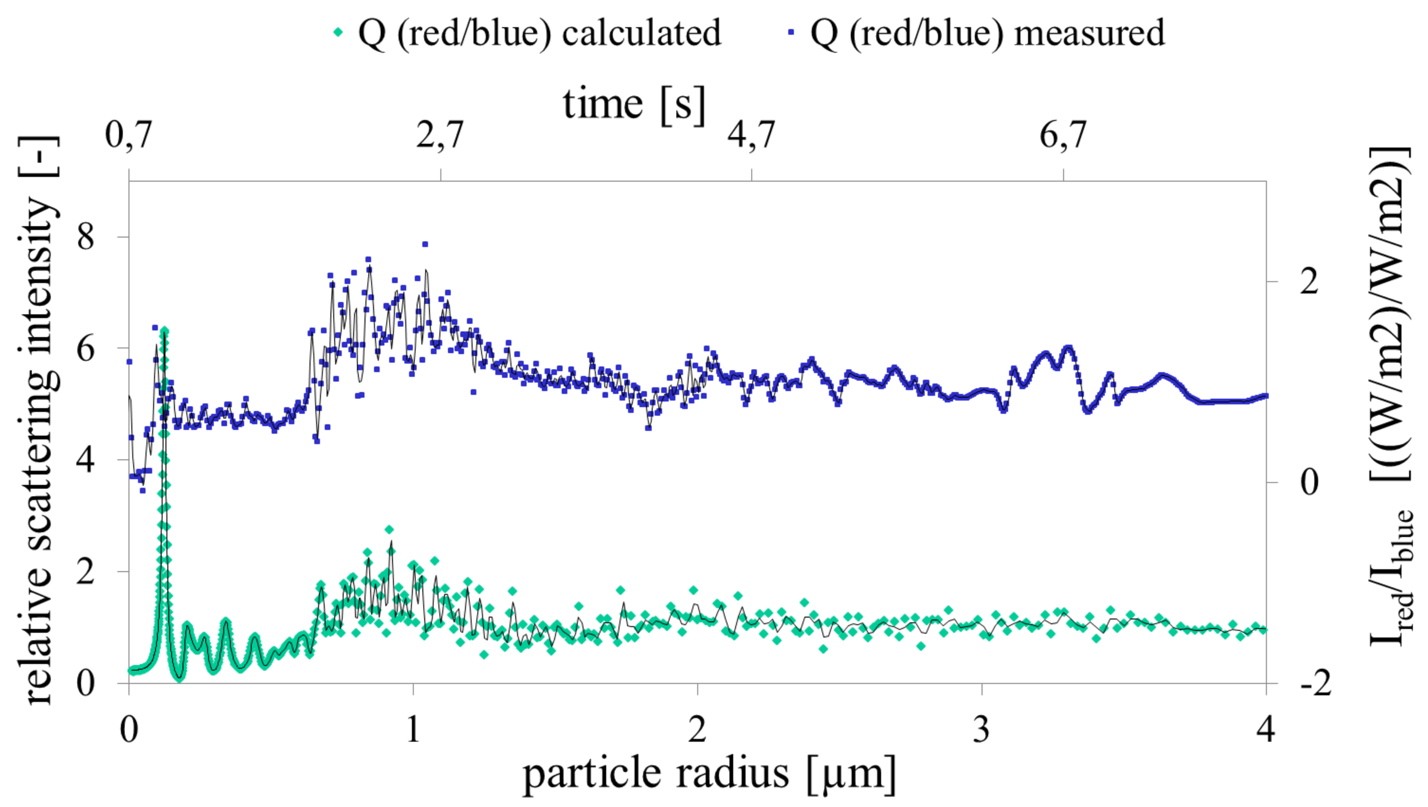

FIG.5: Measurement of calcium oxalate throughout precipitation reaction

The reaction occurs as follows:

$$C_2H_2O_4 \cdot 2H_2O \; + CaCl_2 \cdot 2H_2O$$

(oxalid acid – dihydrate) (calcium chloride – dihydrate)

$$\rightarrow \; CaC_2O_4 \; + 2\,HCl$$

(calcium oxalate) (hydrochloric acid)

RESULTS / CONCLUSSION

These methods allow **determination of particle size** as small as 250 nm as well as the detection of slow growing particles. With this additional knowledge regarding precipitation reactions in beer, **improved quality measurement** equipment for the brewing industry can be developed. The lack of accurate data regarding the imaginary and real components of the refractive indices, as well as non-spherical and non-homogeneous particles, is a known challenge for laser diffraction methods. In a defined environment however like during beer production, where all likely particles can be characterized this can be turned into an advantage. It is proposed that **through backward calculation** of light scattering, together with possible refractive indices, **conclusions about the particle** nature can be made. An early stage detection of such contaminants can help to optimize the stabilization agents and avoid long-term stability testing for beer.

BIBLIOGRAPHY

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