Preface

Particulate solids are attractive educts for the synthesis of colloids due to the availability of many materials as powders that can be handled occupationally safe as suspensions. Mechanical wet-grinding benefits from these advantages but bears drawbacks due to product contamination by grinding body abrasion. Further, especially hard or ductile educts are rarely accessible as nanoparticles by wet-grinding methods. Also the chemical modification is limited and can hardly be controlled by milling. The abrasion-free physico-chemical particle suspension processing by laser irradiation address these issues.

Prior to the work of Marcus Lau, presented here, several international studies on laser fragmentation and laser melting showed the general potential of the method. But all these studies could not extract data about the specific energy input or derive scaling parameters. These earlier studies focus on the final particle size and their composition, but are not investigating in detail the development of particle properties over time and the influence of laser and fluid parameters on the fabricated inorganic nanoparticle colloids. But exactly that is required for an additional understanding in this relatively new synthesis approach.

For this purpose Dr. Marcus Lau developed independently a comparable simple but useful apparatus and studied the influence of fluid, laser, and material parameters on the yield and properties of the particles irradiated with high power lasers. He exploits this new set-up for detailed studies of the process with selected model substances. This advanced technique enables a highly demanded quantification of the specific energy input, the passage quenching, and the identification of intermediates during the process, what gives insight into particle property development.

This book “Laser fragmentation and melting of particles” gives a general understandable introduction into the field of laser fragmentation and melting of particles. The presented state of the art summarizes the comparably young method of laser fragmentation of particles and the even younger method of laser melting of particles. Within the experimental studies he uses different educts as model substances such as metals (Au, Al), a semiconductor (ZnO), metal precursors (Cu_3N, CuO, Cu_2N, CuI) and a material combination (Au/ZnO) to show that mechanistic insights and technical relevant applications are possible. The

investigations demonstrate that particle properties and the particle chemistry can be modified and yield-optimized by irradiation with high power, short and ultrashort pulse lasers.

The experimental work demonstrates that the developed passage reactor is suitable to control the specific energy input and energy density to manipulate the particle properties of different materials by laser irradiation. The different material characterization methods reveal that after each passage (irradiation cycle) particle properties can be adjusted with impressive accuracy. Furthermore, the experimental results and the modelling of the process demonstrate that this colloid synthesis method is close to overcome the lab scale. Additionally the results give insight into the possibilities to fabricate new materials. This is shown exemplarily for gold nanoparticles supported on zinc oxide particles that are successfully inverted resulting in inclusions of nanoparticulate gold in a zinc oxide matrix.

The dissertation of Marcus Lau is a pioneering work especially for the mechanistic understanding, to identify intermediates, and for upscaling for the laser irradiation process of particles in liquids. Enjoy reading, like I did.

Prof. habil. Dr.-Ing. Stephan Barcikowski

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