Visible Sizing

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The sizing of paper products is one of the most important process steps within the added value chain of many paper and board grades. Even though sizing with so called reactive sizing agents like alkenyl succinic anhydride (ASA) and alkyl ketene dimere (AKD) was implemented in the paper industry during the change to neutral and alkaline paper making, there is no total clarity about the detailed chemical and physical mechanisms that lead to their sizing performance. A number of previous research was carried out on the role of different factors influencing the final sizing performance like covalent bonds between the sizing agents and cellulose, the degree of ASA and AKD hydrolysis, size revision as well as the most important process parameters and additives for paper making. However it was not yet possible to develop a holistic model for the explanation of the sizing performance given by ASA and AKD. The goal of this project was to develop a novel physico-chemical approach to this problem, by including results from previous research and combining these with a newly developed method that allows tracing back the actual localization of the sizing agent within the sheet structure.

Therefore a novel method for optical localization of sizing agents by reflected-light microscopy was developed. This method is supposed to be applicable for ASA and AKD, whereas this presentation only focusses on ASA. In order to fulfill the requirements of a reflected-light microscope at magnification rates of a factor 100 optical zoom, it was necessary to improve the contrast between ASA and cellulose. Therefore ASA was dyed with an especially for this process selected dye. This dye was chosen because it doesn't have any impact on the sizing nor the handling properties of ASA. Laboratory sheets, which were sized with dyed ASA were analyzed by means of their sizing performance in correlation to measurable ASA agglomerations in the sheet structure. The sizing performance was measured by contact angle and ultrasonic penetration analysis. Agglomerations of dyed ASA were analyzed manually after field imaging of an area of approx. 6000 µm² with a minimum resolution for agglomerates of 500nm in size. Full factorial design of experiments (DEO) was implemented for result interpretation.

The results of the trials, which were carried out on a laboratory hand sheet former (RDA), show that there is a defined correlation between the amount of sizing agent added and the number and area of ASA agglomerates to be found in the sheet structure. It was also possible to show that the agglomerations are affected by external factors like the presence of retention aid or differing curing temperatures. In addition to these results, a correlation between the agglomeration behavior and the sizing loss (fugitive sizing) during artificial aging was elaborated.

This enables a totally new approach to the explanation of sizing performance, because it is now possible to not only look at the performance of the present amount of sizing agent in the sheet structure, but to closely look at the position the sizing agent is predominantly located at in the sheet. This is very helpful for a possible explanation, which determines the phenomenon of sizing as a chemical process or a rather more physical one. By knowing this, and by being able to control and influence the sizing agent's position in the sheet structure, it should finally be possible to decrease the necessary amount of sizing agent significantly, while not influencing the sizing performance.