Research Institute:
PTS Heidenau
Pirnaer Str. 37
01809 Heidenau

Internet: www.ptspaper.de

Head of the research institute:
Dr. Frank Miletzky

Project leader:
Dr. Daniel Weinzierl
Tel: 03529 / 551-711
Fax: 3529 / 551-889
E-Mail: daniel.weinzierl@ptspaper.de

Research area: Product aims
Paper, paperboard and board // Technical speciality papers

Key words:
Silicon dioxide, microporous coating

TITLE:

Nanoscale SiO_2 dispersions for cationic, microporous coatings

Background/Problem area

Coatings give rise to the optimisation and enhancement of performance characteristics and fields of application of materials. In the paper industry, coating is the most important upgrading process. Paper coatings are capable of significantly expanding the range of paper properties. The requirements on a coating that is used as the ink receiving substrate in a photo inkjet paper are especially high. It must be capable of absorbing 20-30 mL/m² of liquid very quickly. The shape of the particles must also be suitable for achieving such great porosity. Structures that are as irregular as possible, ideally fractals, are advantageous. The research project described in this paper is being conducted using pyrogenic silicas in such photo inkjet coatings. The cationic, acid-stabilising dispersion of SiO2 is not possible for practical purposes, since the oxide reacts like an acid and even at pH 1 the zeta potential only attains a value near zero. After the charge of the pigments has been reversed using poly-(Diall¬yl¬dimethyl¬ammonium¬chloride) “poly-DADMAC“, however, this dispersion is successful. A phenome-non associated with dispersions of pyrogenic SiO2 is the maturation time. Freshly prepared dispersions coagulate when polyvinyl alcohol (PVA) is added. As the dispersion continues to mature, however, the viscosity of such mixtures decreases steadily. The causes are unknown. In view of the storage requirements and the logistics associated with the intermediate storage of dispersions, avoiding or preventing such maturation is economically important. In addition, the use of high-shear procedures can shorten, but not entirely avoid the maturation time. In addition, it also gives rise to considerable costs owing to the extensive wear the dispersion systems suffer.

The problem area can therefore be described as follows:

The dispersion of pyrogenic silicas requires better knowledge of colloid-chemical possibilities. Restrictions of the electrostatic stability require additional stabilisation via steric effects. The relationship of pH and dispersion stability is unfavourable for productivity and the product properties of microporous ink receiving substrates. The measures currently necessary in order to use pyrogenic silica (thinning, high shear, intermediate storage, slow processing) are cost-intensive and relativise the favourable price of the raw material with respect to other alternatives such as aluminium oxide.

Objectives/Research results

The objectives of this research project are to investigate the potential steric stability of SiO_2 dispersions using the manufacture of highly filled inkjet coating colours as an example, to avoid the maturation of SiO_2 dispersions and to throw some light on the physical-chemical processes that occur.

The desired results of the research project include: polymeric dispersion aids and processes that make it possible to produce highly filled, low-viscosity SiO_2 dispersions at pH 4.5, a dispersion formulation for the production of cationic, transparent, highly absorptive SiO_2 dispersions like those required for photo inkjet coating colours, as well as an avoidance strategy for maturation-related intermediate storage of dispersions of pyrogenic silicas in the production of photo inkjet coating colours.

It was found, that the following factors lead to a decreased maturation time:

- Higher pH value of the dispersion
- Increased cationization
- Higher application of dispersing energy

Application/Economic benefits

A comparison of Al oxides and Si oxides reveals significant differences in the production costs with a cost advantage for SiO_2 of up to 50 %. This advantage will continue to grow in view of the expected rise in energy costs. This raw material cost situation is by far the most important motive force behind the use of SiO_2 in the inkjet sector. The special aspects associated with SiO2 processing, however, do not allow the full benefit of this cost advantage to be derived. This explains why SiO2 has still not been able to establish itself as the standard for photo inkjet pigments.

The development of a process for producing highly filled, low-viscosity SiO_2 dispersions at a moderate pH and the development of a concept for avoiding the maturation time before the further processing of the dispersions to form coating colours will provide industry with new coating materials. These materials will be used first in the paper industry. The modified polymers that might be required as dispersion aids will expand the product line of the chemical industry. In addition to the benefits yielded by the research results in the paper industry itself, it is possible to transfer them to the SME-relevant sectors by manufacturing the special-purpose chemicals on the part of a small and flexible supplier, thus making the transferability of the results to other applications conceivable within the scope of technology consultation and transfer. These achievements will support SMEs in their attempts to improve their products or more quickly market new products and to expand the range of applications and market share of inkjet printing by providing more inexpensive and tailored surfaces. Increase in turnover in services companies, e.g. photo-finishing service providers.

Period of time: 01.10.2010 – 30.09.2012

Remarks

The research project IGF 16486BR is being funded by the German Federal ministry for economics and technology (BMWi)