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Agglomerates in paper coatings

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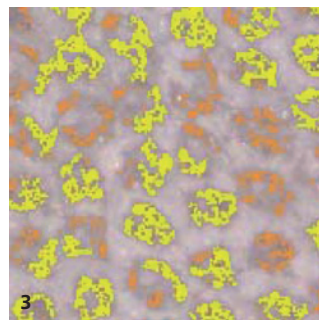
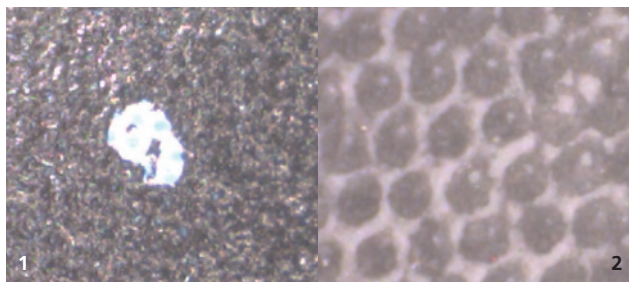
Agglomerates are small clumps of material increasingly found in coating pigment by various studies in recent years. The size of these agglomerates ranges from the order of 10 μm – i. e. beyond the limit of human vision – up to about 1.5 millimeter. Agglomerates in coating materials are often mixtures of latex, co-binders and pigment, although they may not necessarily be visible in the unprinted finished paper.

Agglomerates can only be measured with relative difficulty because their modified wettability makes it impossible to discern them with an IGT tester's measured values. Instead they can only be differentiated from their white surroundings due to lack of ink transfer and surface wetting and ink adhesion. Locally there are clear differences in wetting with water or other measurement fluids. However, depending on their distribution, it can be particularly difficult to locate the precise

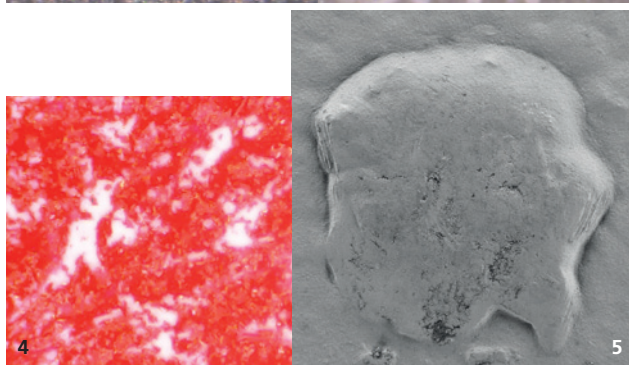
point of the agglomeration. Often there are only a few agglomerates spread across the coated surface and, as such, they are not visible.

Short blade streaks of 5 to 30 cm in length are also indicative of agglomerates, but in this case they have already grown to a critical size. Recently, agglomerates have been identified as having grown to such a size as to cause deleterious effects in the printing of halftone dots; causing uneven printing (halftone mottling). In some cases the halftone dots are significantly deformed and no longer seen as a clear dot.

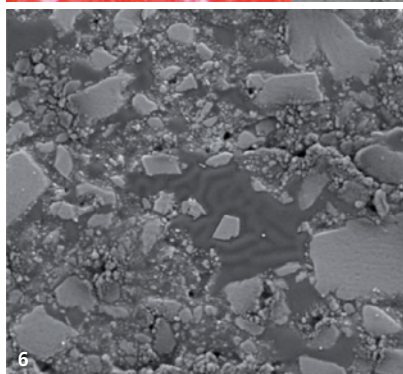
Agglomerates always form at the boundary layers of liquids, i. e. where two liquids mix, or at the boundary layer of air or the material surface, especially at boundary layers with significant differences in temperature, pH value, air and chemical reactions between liquids and components.



Pictures 1 to 3 shows agglomerates which were only detected by microscope (Digital Pocket Microscope 100) after printing because of the uneven printing appearance



Reaction with air has a dual significance here. For one thing, air causes drying, i. e. the formation of a skin at the interface. At the same time, air bubbles also cause agglomerates to accumulate. It is this accumulation of agglomerates around the air bubbles created by the hydrophilic/hydrophobic boundary layer which leads to an entirely new appreciation of foam control in coating pigment preparation and on the machine.



Pictures 4 to 6 shows agglomerates in the printed surface and even in a print dot

Micro-agglomerates with a diameter of $<30 \mu\text{m}$ collect around the air bubbles and these micro-agglomerated adhere to each other to form even larger agglomerates. The coating is actually drying within the air encapsulated by the foam bubble. If the air bubble bursts, that skin or drying coating film still remains intact like an empty balloon and agglomerates of 0.1 to 0.2 mm form. Those agglomerates are soft enough to pass through a filter, and continue to grow in size. In the boundary layer, defoamers which remain in circulation due to their low shear stability are no longer effective due to their reduction below a critical size.

Coating pigment defoaming and the compatibility of raw materials take on a greater importance as result. Agglomerate content determinations should be prior to the appearance of visible blade streaks in order to prevent the number of agglomerates from growing during critical production runs, thereby preventing the degradation of printability.

Along with the traditional methods of compatibility testing (fisheye test), one strategy for avoiding agglomerates includes testing at different coating thicknesses as well. For example, it has been demonstrated that 30-, 60- and 90- μm -thick drawdowns with laboratory blades onto laboratory black/white hiding charts with sealed and unsealed surfaces (Penopak from BYK-Gardner) significantly enhances the ability to assess agglomerates with a microscope (DPM from BYK-Gardner).

Moreover, it is useful to define a reference area in the coating pigment preparation (at the heat exchanger, for example), in order to assess deposit formation. Agglomerates also collect and form within the island of foam bubbles that typically forms at the stirrer shaft of agitated tanks; the charged surface of the foam bubbles act to collect these hydrophobic agglomerates thus forming larger agglomerates.

Especially within the recirculation lines of coating color, the combination of air, heat and foam is often present and existing agglomerates grow until they are large to cause coating defects. So in addition to the necessity of the uniform application of the coating colour, the air content of the coating color must also be controlled to minimize the formation of sufficiently large agglomerates to cause defects. Time and shear forces are also essential factors. With all shear the coating is subjected to from pumping, recirculation, remixing, etc. the coating is destabilized by the shear and/or the duration of shear to form agglomerates.

Adhesion forces also come into play; Small sticky agglomerates will grow in size. The different systems of

the surface-active substances comprising binders, pigment dispersions and additives can create incompatibilities which also reduce effectiveness, thereby increasing the consumption of additives and binders. In some cases, the uneven distribution of binders and additives has severely degraded technical properties. That is why controlling boundary layer activities can also reduce costs.

BYK Additives & Instruments has been studying boundary layers and their control for many years. For paper coating, defoamers have been developed with high shear stability, thereby reducing the formation of agglomerates. Accompanying analytical methods and test routines have also been developed to prevent or significantly reduce agglomerate formation. With the recent advanced developments of coatings, pigments and the substitution of raw materials for cost optimization, the frequency of agglomeration defects has increased.

Due to improvements in process control, stable production operating window conditions have been narrowed, so that disturbances or defects occur only under extraordinary conditions – but then lead to huge application problems such as blade streaks or printability problems. The importance of the proper defoamer selection must not be underestimated as the effectiveness of the defoamer depends not only on their primary defoaming function, but also on how they interact with the coating colour composition and the mechanical conditions the coating colour is subjected to during storage, transport and application.

In various cases, our studies have made it possible to develop strategies to minimize disturbances such that the stable production window is less prone to flaws and the appropriate countermeasures can be introduced immediately. Particularly in the coating pigment formulation, interactions in boundary layer chemistry are playing an increasingly important role in cost optimization and productivity. ■