New EA Toners for High Quality Digital Color Printing

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Abstract

Digital toner based printing technology is a growing segment of the Digital Production Printing, in which high print quality, low cost, fast printing and wide range of substrates are of critical importance. However in meeting these new challenges, the old toner materials produced by conventional melting and grinding technology were insufficient for the task. Therefore, a need was apparent to develop new xerographic toner material capable of responding to the demands of digital printing.

This talk will discuss EA toner technology, which produces what is called new xerographic EA toner that can improve the quality of printed materials and lower printing costs. EA refers to the environmentally friendly chemical process called emulsion aggregation, which creates very small toner particles by aggregating and coalescing sub-micron polymeric latex and pigment particles.

Due to the "assembling" nature of the process, toner particles are precisely controlled in size, shape, structure and color, so that the color prints from xerographic printing exhibit image quality indistinguishable from the traditional offset printing. EA toner particles can be designed at the nanostructure level, thus allowing for tuning of the material for the specific machine design. Smaller size toner particles that parallel the smaller pixels on the image screen can provide sharper images resulting in better resolution and print quality. Smaller size can also reduce image thickness leading to lower toner usage and less energy needed to fuse toner to the paper. Controlled (spherical) shape means better toner transfer in the machine and less toner wasted leading to a high quality product that is lower in cost per print and more affordable to the customer.

EA Process for Making Toner Particles

EA toners are prepared by growing desired size toner particles from small polymeric particles dispersed in water (latex), small colorant particles (pigments) and optionally wax and/or other components also dispersed in water. The main function of polymeric resin is to provide adhesion of toner to substrate (paper), while pigments are needed to provide specific colors, and wax can be required for oil-less release of image from the fuser. Since the polymeric resin (latex) is prepared by emulsion polymerization and the process of bringing together latex, pigment and other components is called aggregation – the toners are called Emulsion/ Aggregation (EA) toners.

The EA process is significantly different from the conventional way of making dry xerographic toners. In both cases the target is to prepare toner powder that is less than ten microns. In the conventional method this is achieved by grinding larger chunks of colored polymer to the desired size, while in the EA process the desired size is assembled from smaller components.

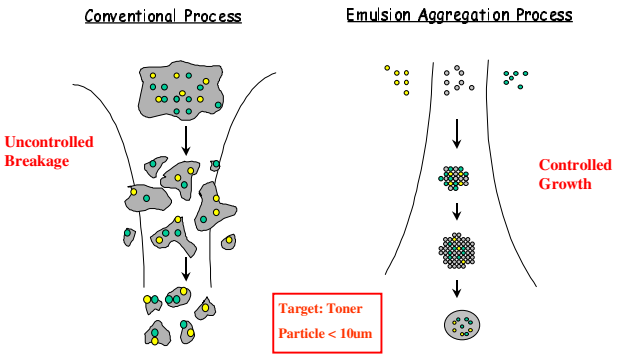

Figure 1. EA vs conventional process for making toner particles.

Since the breakage (grinding) can not be well controlled, the conventional process creates a wide range of sizes and requires additional classification to obtain the desired particle sizes. On the other hand, the EA process is well controlled producing uniform particles of a specific size range without classification. Since the trend in toner particles leans towards smaller sizes (for better image resolution), the EA process becomes more attractive given that it can produce 3-10 micron particles with very narrow particle size distribution.

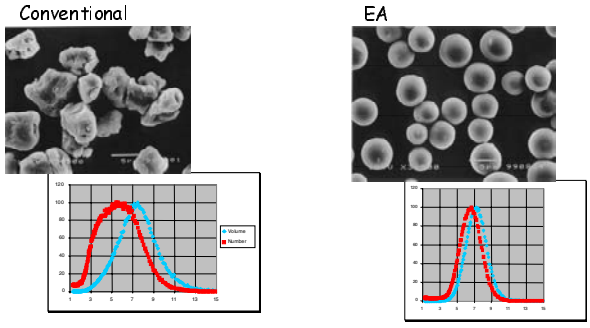

Figure 2. Particle shapes and distributions produced by EA and conventional processes.

This process is also more environmentally friendly in that it requires less mechanical energy to produce smaller toner particles and it reduces CO_2 emissions by ~35% in manufacturing. EA is also a water-based process (unlike some of the other chemical toner processes); it does not utilize any harmful solvents in its manufacture. After particle separation and drying, particles are blended with additives in the same way as other toner processes.

Features of the Toner Particle Enabled by EA

Due to the assembling nature of EA process, control of not only the size and distribution but also the shape and the structure of the particle is possible. This enables preparation of encapsulated particles (core-shell structure), with the specific components positioned within the particle where needed.

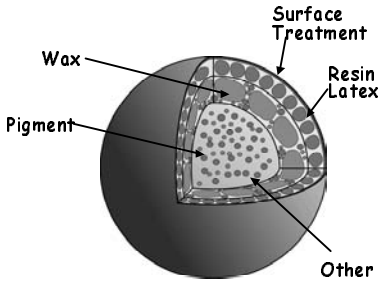

Figure 3. Structured EA toner particle.

This means well-controlled and uniform charging properties, excellent flow and transfer efficiency. This kind of flexibility in particle processing enables new toner designs, therefore enabling the EA toner to be designed for the specific hardware - no "one size fits all" solution. The EA process also enables very fine and uniform dispersion of the colorant (pigment) in the toner particles. The encapsulation of a particle (core-shell structure) prevents pigment from forming on the surface allowing similar charging properties to be achieved for a variety of colors, generating consistent color output.

Moreover, the EA process opens up a wide range of resins to be used, since the grinding requirement does not have to be met. Of special importance are low melting resins, which can enable faster machine speeds and wider range of substrates.

Performance Attributes Enabled by EA Toner Design

Small, very uniform toner particles enable much better line and dot resolution and image sharpness. Small regular sized particles also mean a thinner layer of the toner is used to create an image.

This translates into off-set like images having no raised image toner feel, no paper curl, uniform gloss and better coverage on rough papers allowing for usage of a wider range of media. Due to the excellent homogeneity of the pigment throughout the particle, EA can produce uniform color images. Toners can also be designed with internal wax yielding oil-less fusing. This means no oil streaks on an image, more uniform gloss and better image quality. Additionally, oil free Xerography makes writing on the image and self-stick (Post-it ™) note attachments possible.

This new EA color toner demonstrates more consistent output, improved dot and line reproduction, better halftone and solid fills.

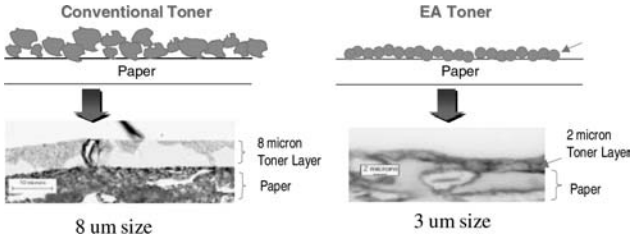

Figure 4. Thinner toner layer on substrate enabled by smaller EA toner.

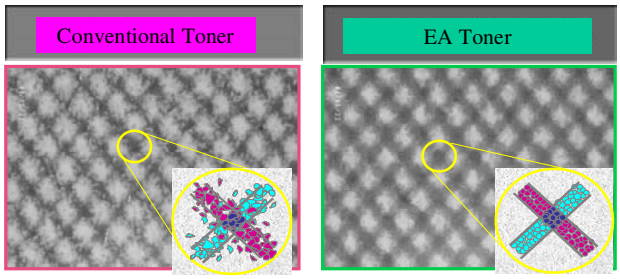

Figure 5. Improved Image sharpness with EA toner.

Economics Enabled by EA Toner

The thinner toner layer on paper means less toner is used to create images or in other words more prints from the same cartridge. Furthermore thinner toner layers require less energy to fuse the toner to the paper (lower fuser temperature = extended fuser life), it can also enable faster machine speed at the same fuser temperature as well as widen the substrate range.

Special EA lower melting polymer designs enable lower set point which yields instant warm up time. Quick warm up time means the machine is always ready for customer use. Moreover designing toners with internal waxes enables elimination of the oil system from the machine.

The aforementioned improvements seen in EA toner mean lower cost of the hardware along with higher machine reliability leading to fewer service calls, and improved cost (25-35% improvement).

Very uniform rounded particles also mean excellent transfer efficiency; as a result little toner is wasted in the machine and nearly all is used for creating the images. All of these factors mean lower total cost of ownership for the customer.

Conclusions

New EA toner due to the tight control of particle size, distribution, shape and structure enables preparation of high quality, high resolution xerographic images. Due to the flexibility in the toner design it is addressing specific

needs of the particular machine design, which eventually is responding to the specific needs of the customers.

Acknowledgements

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Biography

Dr. Grazyna Kmiecik-Lawrynowicz is a Principal Scientist in Material & Process Technology in Supplies Delivery Unit in Xerox, where she is responsible for leading EA toner technology & polymer carrier coating design activities. Grazyna received her MSc&Eng Degree in Chemistry & Chemical Engineering from Warsaw Technical University in Poland, and her Ph.D. in Chemistry from Rutgers University. After postdoctoral at University of Toronto, she joined Xerox in 1988. In 1992 she pioneered work on Emulsion Aggregation (EA) toner at Xerox for future color xerographic applications. Dr. Kmiecik-Lawrynowicz has authored 85 publications, including 68 U.S. patents. At Xerox, she is a recipient of three Eagle Awards for the highest number of patents in the years 1994, 1997 and 1998. She is a member of IS&T and American Chemical Society.