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The investigating and preparation of ceramic ink by sol-gel method

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Just over a decade ago, the only way to decorate ceramic tiles was using traditional printing methods, the most common of which was screen printing and the industry as a whole had little use even for computers. Screen printing was a mature technology with little scope for innovation.

Most of the tiles produced were either plain or unsophisticated with simple and repetitive patterns. It was difficult for manufacturers to make their tiles stand out from the competition and differentiation

The decoration process had other disadvantages, including high set-up costs, long production runs, and the difficulty of exactly matching tile colors on repeat orders.

Today, digital inkjet is the 'must have' technology for ceramic tile manufacturers. It is no longer a case of offering digital as an optional extra; digital capability is expected, and digital inkjet is the only viable option.

Digital inkjet printing has revolutionized ceramic tile manufacturing in a very short time, the revolution began in Europe, where digital ceramic tile decoration flourished in the difficult economic conditions from 2008 onwards. We are now seeing the change from traditional to digital ceramic tile decoration gathering momentum in the rest of the world. China,Brazil and India, countries with an enormous installed base of traditional ceramic tile production lines, have already shown a very rapid conversion to digital inkjet decoration.

The traditional production process has several disadvantages. The most serious weakness, however, is in the decorating process, because roller screen printing is a contact printing technology. This has a negative impact on ceramic tile manufacturing in a number of important ways.

For instance, long set-up time, color management is difficult, inflexible production planning, patterns repeat frequently, only flat tiles can be decorated, tile breakage is more common and high stocks of finished goods and work-in-progress.

For ceramic tile decoration, the first major advantage of digital inkjet is that is a non-contact process. Another one is creative benefits such as there is no roller and the third is faster set-up and the last one is rapid payback- in less than six months; due to these factors, producing digital ink for inkjet is on the rise.

As we have seen, today digital inkjet decoration has been widely adopted in Europe, where it has become the essential technology for ceramic tile manufacturers, and is now also growing rapidly on other continents, but its success did not come overnight.

We need to briefly explain how a print head jets drops of ink onto the substrate (in this case, the ceramic tile) to create the image. There are two basic ways of doing this continuous inkjet or Drop-on-Demand (DoD) inkjet. Digital ceramics decoration printers used DoD.

DoD printing means that a drop of ink is only generated when it is needed, so ink waste is minimized. To do this the ceramic decoration printers use piezoelectric inkjet print heads. The active components in these print heads are made from a ceramic material (PTZ) that flexes when a voltage is applied to it.

Piezoelectric print heads can work in two ways: direct (bend) mode or shear mode. In direct mode, the electrical field (voltage) is applied to PTZ material in the same direction as it is polarized, which causes it to change in height and width (it becomes longer and thinner).

Ceramic decoration presents several challenges. Firstly, the manufacturing process generates a lot of dust and debris, because the raw material are powders. Secondly, after leaving the press the unfired ceramic tiles are fragile, hot and steaming. Finally, to produce vibrant color, ceramic inks contain large, insoluble particles of pigment, packed tightly together and held in suspension. This makes the ink very viscous and liable to settle, causing sedimentation.

Around the world, the conversion of production lines to digital inkjet decoration continues. Just as this first wave of digitalization sweeps through, a second wave is arriving, one that provides ceramic tile manufacturers with even more ways in which they can differentiate their products from their competitors.

Digital deposition also benefits another emerging area of ceramic tile manufacture-large, thin tiles, which are manufactured by extruding the base material rather than by pressing it.

As with the first wave of digitalization, innovative new print head technologies are driving these developments, because digital printers that add structure and relief need to be significantly different from the digital decoration printers used today.

This summary has described the benefits of digital decoration of ceramic tiles and the necessity of digital ink; reduced wastage, more flexible production, higher quality, wider product ranges, and so on.

In this paper, we have synthesized digital ink based on Co-Al for ceramic tiles which is used in inkjet printers. For producing digital ink, first of all providing pigment is vital and necessary.

Due to above sentences, this project includes two steps, first step is producing of pigment and the second one is synthesis of digital ink. Here it is considered to synthesize blue pigment and blue ink.

Firstly, we have synthesized cobalt alumina ($CoAl_2O_4$), nano powders as blue pigments bythe combustion sol-gel method, Which $CoSO_4.7H_2$O and $Al(NO_3)_3$ were used as a precursor materials and mixture of urea and glycine as fuel. The prepared nano CoAl2O4 pigments were characterized by means of X-ray diffraction (XRD), transmission electron microscope (TEM); In fact the structure of pigments is assigned based on XRD and TEM.

The presence of $CoAl_2O_4$phase was confirmed by XRD. The crystallite size of powder was estimated in the range of20-30 nm and the morphology was investigated by means of TEM.

During the production operation, especially during drying and grinding, pigments tend to collect to form larger crystalline structures, in other words to agglomerate and to aggregate. When these agglomerates are being incorporated into the application medium, they have to be separated into their individual constituent particles; so dispersion of pigment is essential to achieve appropriate ink.

According to abovethe most important thing for synthesizing of ink is dispersion of pigments and choosing a suitable material to disperse pigments in an organic solution so in the present work, we investigated the aggregation behavior of pigments by adding surfactant.

So, in the next step we focus on synthesis of ink, which the blue pigment which was synthesized in first step, a surfactant and an organic solution as an environment for dispersing the pigments were used. CTAB(Cetyltrimethylammonium bromide) was chosen as a surfactant and ethylene glycol was used as an organic solution which pigments could be dispersed in by CTAB.

Above all, digital is a technology that meets the requirements of manufacturers, retailers and their customers in a competitive world. These benefits are not expensive. A typical digital decoration printer can be paid for in less than six months of ceramic tile production, and so the investment is not difficult to justify. In addition, digital is simple to integrate into existing lines, and so disruption to production is minimal. The arguments for digital are compelling, which is why digital inkjet ceramic tile decoration printers are rapidly becoming the dominant decoration technology. Combine the prospect of digital printers that can apply structure and relief as well as decoration with a global ceramic tile market that is currently growing at around 6%, and the opportunities are huge for those companies who embrace digital decoration; due to day by day synthesis of digital ink is necessary and practical in ceramic industry.

The procedure which was used in present work is economical and simple with accessible material and it is a new side to produce digital ink because some current methods are complex and expensive so they are not suitable and not to be profitable.

All in all this paper demonstrated that inkjet printing technology can be used to produce nano-pigment films on the ceramic surface.