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Influence of Z number and Pulse Voltage on Drop-on-Demand (DOD) Inkjet Printability

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Abstract

Inkjet printing has been applied in manufacturing structural and functional materials for decades. There are two kind of methods known as continuous inkjet (CIJ) printing and drop-on-demand (DOD) inkjet printing. [1] In DOD inkjet printing, drops are generated only when a drop needed by producing a pressure pulse in a chamber filled with inks. And before drop generation, the inkjet printing head will be moved to the desired location to locate the drop in a precise position. DOD inkjet printing is a method that directly places materials on demand, which saves the required raw materials and reduces the printing steps. As a consequence, DOD inkjet printing saves more time with lower waste consumption during production than CIJ printing and the equipment has a smaller footprint.

DOD inkjet printing can be divided into two methods by which the pressure pulse is generated followed by drop ejection: thermal DOD inkjet printing and piezoelectric DOD inkjet printing. In piezoelectric DOD inkjet printing, the pressure pulse is produced by the mechanical actuation of the chamber walls. [2] When a voltage is applied, the piezoelectric material changes shape, which generates a pressure pulse in the fluid forcing a droplet of ink from the nozzle. It is important to know the inkjet printable range to generate accurate and repeatable drops. Fromm had defined ink printability in drop on demand (DOD) printing using a dimensionless Z number which related to the physical properties of the inks. [3] However, it is still not agreed whether there is a precise Z number range for inkjet printability and not known whether the range varies using different actuating pulses.

The goal of our study is to find out the detail relationship between the ink properties and Drop-on-Demand inkjet printing printability and explore whether the printable Z number range change with actuating pulses and different kind of printheads.

Here we investigate the influence of Z number and pulse voltage on printability using two inkjet printheads (10 pl Dimatix and 80 μm MicroFab). We have used 10 model inks made from solvent mixtures of ethylene glycol, diethylene glycol and distilled water. A range of actuating pulse voltages has also been studied. We found that the printable Z number range changes with the pulse voltages applied on inkjet printing. When increasing pulse voltage to print the same ink, it becomes printable under low pulse voltage and flying slow in the air and then printing well until at a certain voltage satellites forms and more satellites form when further increasing the pulse voltage. We also found that the printable voltage range is slightly different among inks with $Z > 8$. Under higher pulse voltages, it is possible to get single droplets with $Z < 4$, but inks with $Z > 4$ are printed out with some satellites. However, accurate and stable drops without satellites could be formed using inks of $Z > 4$ under lower voltages and it is not printable for inks of $Z < 4$ when printed under lower pulse voltages. These results could give an explanation of the different Z number range shown in different researches published when they using different printheads and pulse voltages.

Key Words

Inkjet printing; Z number; Printability

Biography

Yuanyuan Liu graduated with a BEng in Ceramic Composite Materials from Zhengzhou University, China in 2010. In 2012, she got her Master degree in Materials Physics and Chemistry from Harbin Institute of Technology, China. Then she commenced a CSC scholarship to pursue a PhD on "Inkjet printing of nanoparticle suspensions" under the supervision of Professor Derby. Her research now is mainly focus on the inkjet printing, "coffee stain" and defects in 3D printed ceramics.

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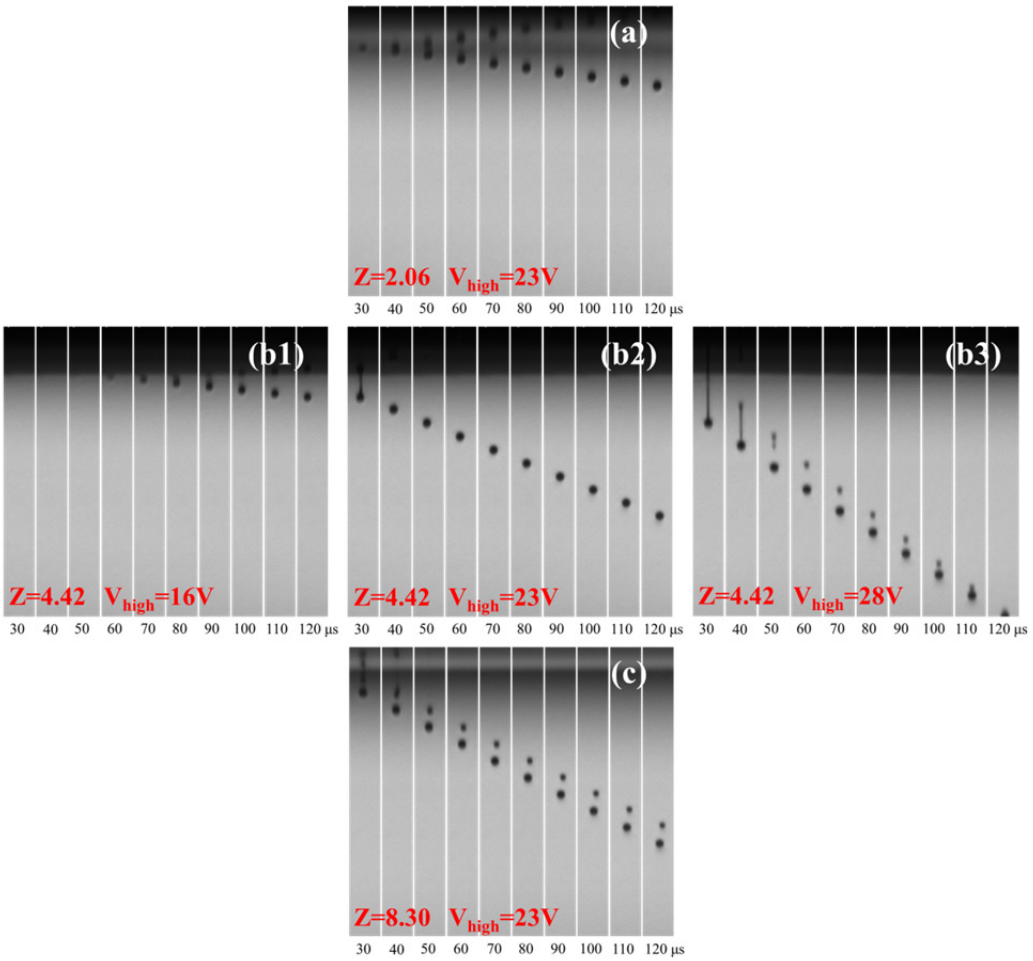

Figure 1. Snapshots of drop formation for inkjet printing inks with different Z number and pulse voltage: When increasing pulse voltage to print the same ink with Z number of 4.42, it becomes printable under 16V (b1); prints well under 23V (b2) and starts satellites formation when printed under 28V. When using different inks under a constant pulse voltage of 23V, ink of Z=2.06 becomes printable (a) and ink of Z=8.30 has satellites formation.