INK JET DEPOSITION OF MATERIALS

Physics, Systems, Methods & Applications of Ink-Jet Based Fluid Microdispensing

OVERVIEW

In the last decade, ink jet has come to be viewed as a precision microfluidics tool in addition to its use in printing. The inherently "data-driven" nature of ink-jet makes it attractive as a flexible manufacturing tool in applications ranging from medical diagnostics to optical communications. In contrast to photolithography and screen printing, ink-jet is an additive process that can minimize the use of expensive materials such as DNA, light-emitting polymers and precious metal inks, among others.

This course is designed for those interested in developing applications of ink-jet technology other than ink on paper. It will help you understand: the basic physics of jetting a wide range of materials; "ink" or fluid and printhead requirements; systems requirements for utilizing ink jet technology in manufacturing; and the range of possible applications. In addition, One or more customer-specified applications will be discussed in more detail. Piezoelectric, demand mode technology will be emphasized in this course.

COURSE LEADER

Dr. David B. Wallace, Vice President, Technology Development,
MicroFab Technologies, Inc., Plano, Texas

Dr. Wallace is an internationally recognized expert in ink-jet physics and applications. He has over thirty years of industrial experience in complex fluid flow phenomena, including twenty-five years in ink jet printing. He has published over eighty articles and has been awarded twenty-eight patents. Dr. Wallace is an Adjunct Professor in Biomedical Engineering at the University of Texas Southwestern Medical Center and a Fellow of the American Society of Mechanical Engineers. He has been Principal Investigator for research funded by the National Institutes of Health, National Institutes of Standards and Technology, National Science Foundation, Defense Advanced Projects Agency, and other organizations. Dr. Wallace received his BSE and MSME from Southern Methodist University and a Ph.D. from the University of Texas at Arlington.

MicroFab Technologies has been a pioneer in developing industrial applications of ink-jet printing technology, in areas as diverse as medical diagnostics, medical devices, electronics manufacturing, optics and displays among others. MicroFab Technologies personnel have authored sixty-four patents covering these developments over the past eighteen years. MicroFab Technologies has supplied ink jet equipment to over two hundred organizations in Europe, Asia and North America.

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SEMINAR OUTLINE

I. Overview of Ink-Jet Technologies ~1 hour

- A. Introduction: why ink-jet, technology "tree", technology drivers
- B. Continuous Mode Ink-Jet Technology
  1. Introduction: overview, block diagram, jet breakup examples
  2. Droplet formation
  3. Droplet charging, deflection, and aerodynamics
  4. Closure: configurations, design space
- C. Drop on Demand Ink-Jet Technology
  1. Introduction: overview, block diagram, drop formation examples
  2. Thermal ink-jet
     a. Design & fabrication overview
     b. Operating principle
     c. Closure: configurations, design space
  3. Other: Acoustic (free surface), solenoid driven; exotics
- D. Questions & Discussion

II. Piezoelectric Drop on Demand Technology - Physics ~ 2 hours

- A. Piezoelectrics
- B. Actuators: types, integration into arrays
- C. Piezoelectric motion, constants, electrical impedance
- D. Fluid acoustics: compressibility, wavespeed, geometry, resonance
- E. Drive waveform and a drop formation event
- F. Drop parameters
  1. Drive waveform & frequency effects
  2. Orifice flow & geometry effects
  3. Fluid properties effects
- G. Drop formation: overview, fluid properties effects
- H. Modeling

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I. Questions & Discussion

End of Session 1

III. Feature formation on substrate ~1 hour

A. Fluid / substrate interaction - porous and nonporous substrates

B. Impact, heat transfer, and phase change effects

C. Fluid properties effects

D. Influence of drop volume & velocity, and printing algorithm

E. Questions & Discussion

IV. Printing Systems ~ 1.5 hours

A. Overview & Block Diagram

B. Fluid system: pressure control, filtration, pressure drop, dead & useful volume

C. Printhead functions: fluid system, temperature control, atmosphere control, interconnects (mechanical, electrical, pneumatic)

D. Environmental control: clean air, solvent removal, inert atmosphere

E. Printer configurations: moving vs. stationery printhead; cylindrical geometries

F. Printing method: vector vs. raster; on-the-fly or point-to-point; data management

G. Printhead configurations: single jet, modular array, integrated array

1. Array performance requirements, issues

2. Array printing: angles or/and interlaced; data manipulation

3. Array printhead examples

H. Hitting the target: jet, substrate, and motion system alignment

I. Errors: trajectory, velocity, volume; effect of flight time

J. Jetting materials, reliability, and maintenance

K. Questions & Discussion

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V. Additional Topics ~0.5 hour

End of Session 2

VI. Applications Overview ~2 hours

A. Introduction

B. Electronics, display, optics, and 3-D assembly manufacturing applications

C. Biomedical applications: bioactive materials printing; tissue engineering; drug delivery; chemical synthesis & analysis; stent manufacturing; laser surgery

D. Sensors

E. Vapor generation applications

F. Other

G. Questions & Discussion

End of Session 3

VII. Customer Specific Application ~2 hour

End of Session 4

Wrap Up

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