



# 유동 가시화를 이용한 잉크젯 프린터 헤드 연구

한국 가시화정보학회 춘계 학술강연회  
2003. 5. 2

손동기  
Ink Jet Project Team  
삼성종합기술원

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## Outline

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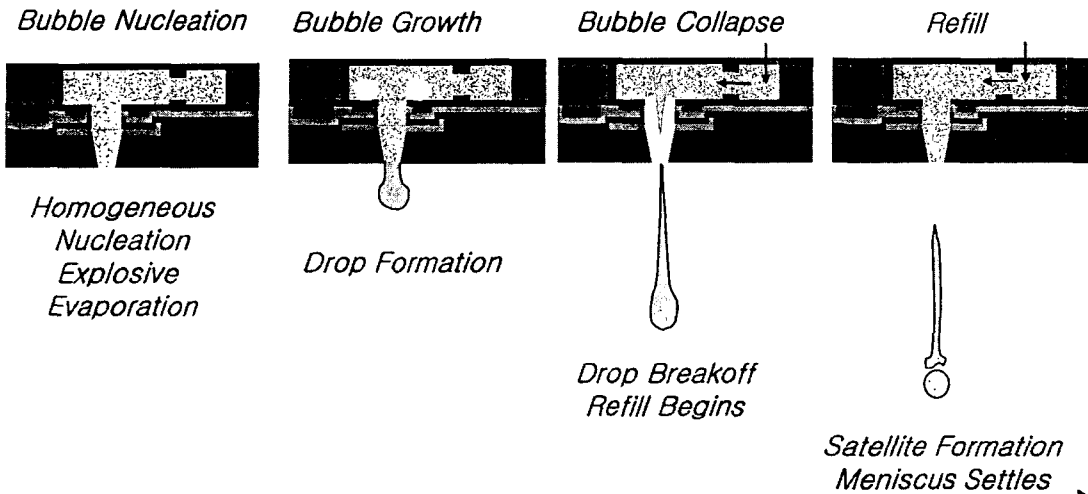
Thermal Ink Jet Operation  
Ink Jet Print Head  
Twin Head Ink Jet Head Structure  
Visualization System  
Open Pool Test  
Ink Jet Head Visualization  
Ink Jet Meniscus Behavior  
Future Work  
Summary



# Thermal Ink Jet Operation

## Facts about Ink Jet

- heating rate  $> 100,000,000 \text{K/s}$
- heat flux  $> 500,000,000 \text{W/m}^2$



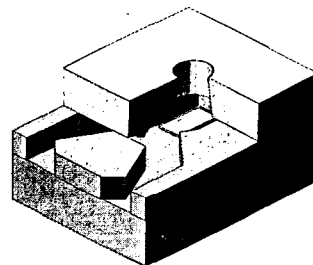
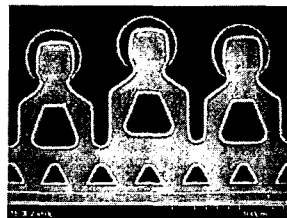
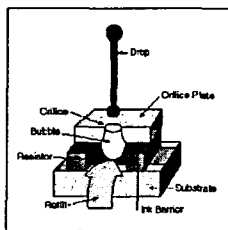
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## Ink Jet Print Head

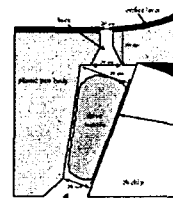
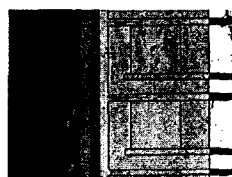
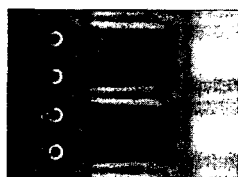
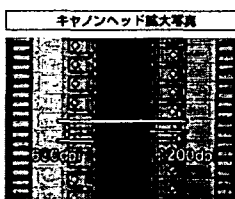
### Thermal Ink Jet - Top Shooter

- HP



- Canon

❖ micro fine droplet technology



Old Canon Side Shooter



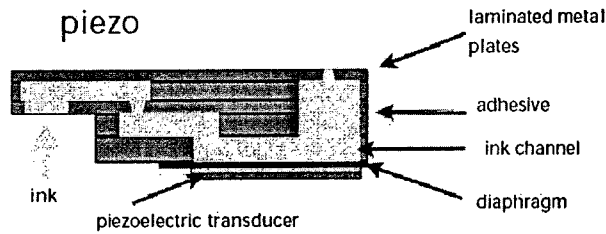
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# Ink Jet Print Head

## Piezo Ink Jet

- Epson



- Industrial Piezo Ink Jet
  - ❖ Textile Printing
  - ❖ Flat Panel Display



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## System Goal

### Printing Quality and Speed

color gamut	color maps
colorant concentration	closed-loop color control
dots per inch (dpi)	dot gain (ink/media interaction)
dot size	dot placement accuracy
dot visibility	dot shape (edge sharpness)
drop volume	drop trajectory accuracy
dynamic range	gamma correction
halftoning methods	number of addressable colors
number of tone levels	paper positioning accuracy
white point correction algorithms	white point correction algorithms
media sensing	environmental (temp., humidity) sensing



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# Issues

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To achieve

- Drop volume : given
- Drop speed : maximize
- Fire frequency limit : maximize

Design of

- Heater
- Chamber
- Restrictor
- Nozzle

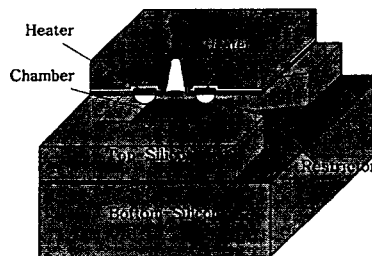
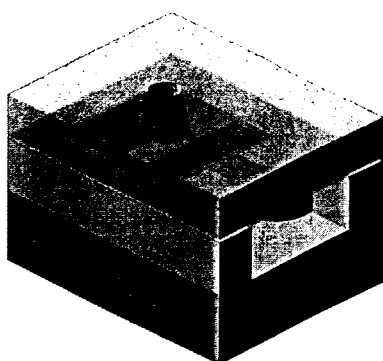
Related Topics

- Bubble formation
- Drop formation
- Drop break off
- Bubble collapse & cavitation
- Refill

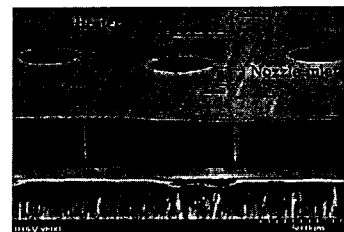


## Twin Heater Ink Jet Head Structure

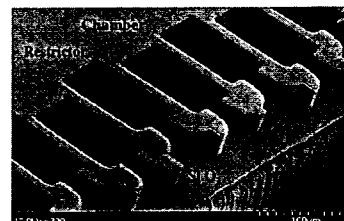
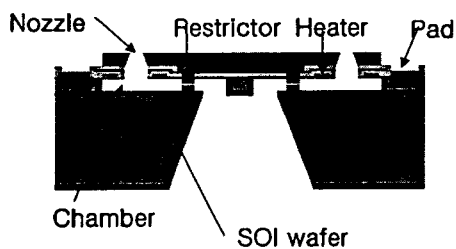
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SEM Picture



Nozzle & supply channel

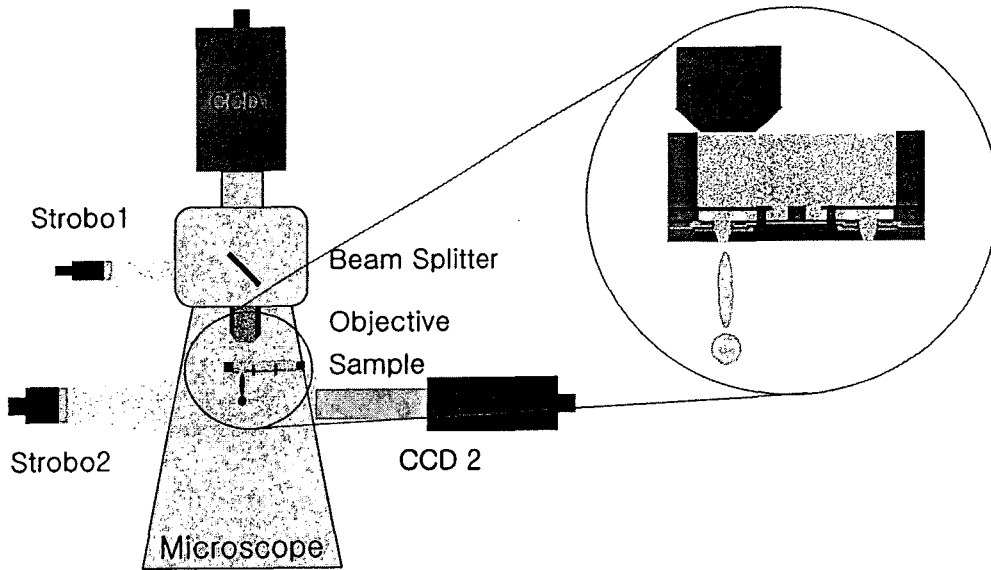


Chamber & Restrictor



# Visualization System

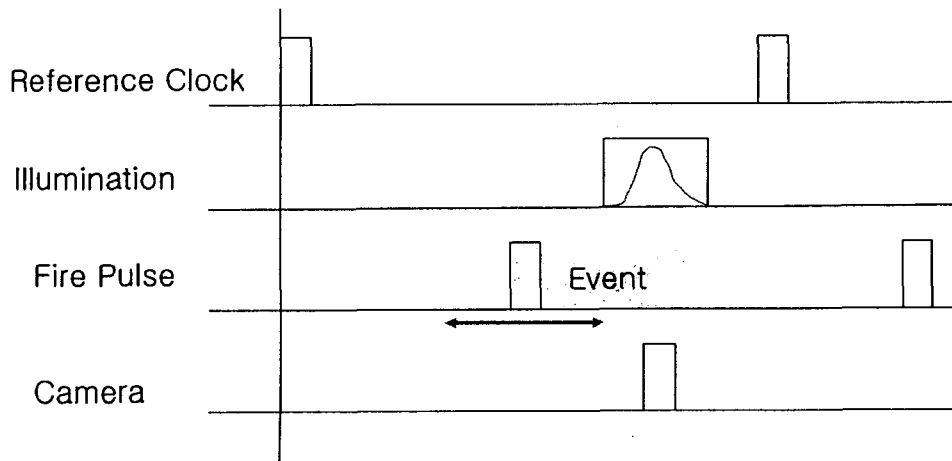
## Microscopic Visualization



# Visualization System

## Pseudo-Cinematography

- Cyclic event recording
- Camera and illumination synchronization



# Visualization System

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## Light Source

- Pulsed

- ❖ Xe - Strobo : Visual
- ❖ Nd-YAG Laser (Dual Head) : PIV, Visual (fluorescence)

- Continuous

- ❖ Halogen Lamp : Visual
- ❖ Ar-ion Laser : Visual
- ❖ Hg Lamp : Fluorescence

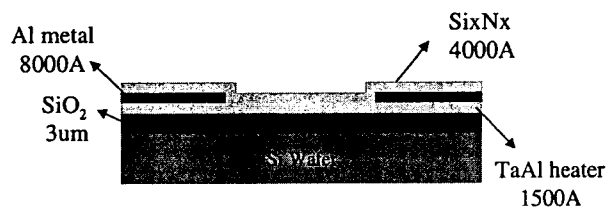
\* Laser 광원은 microscope상에서는 형광을 사용하지 않는 경우 speckle 때문에 사용하기 어려움



# Open Pool Heater Experiment

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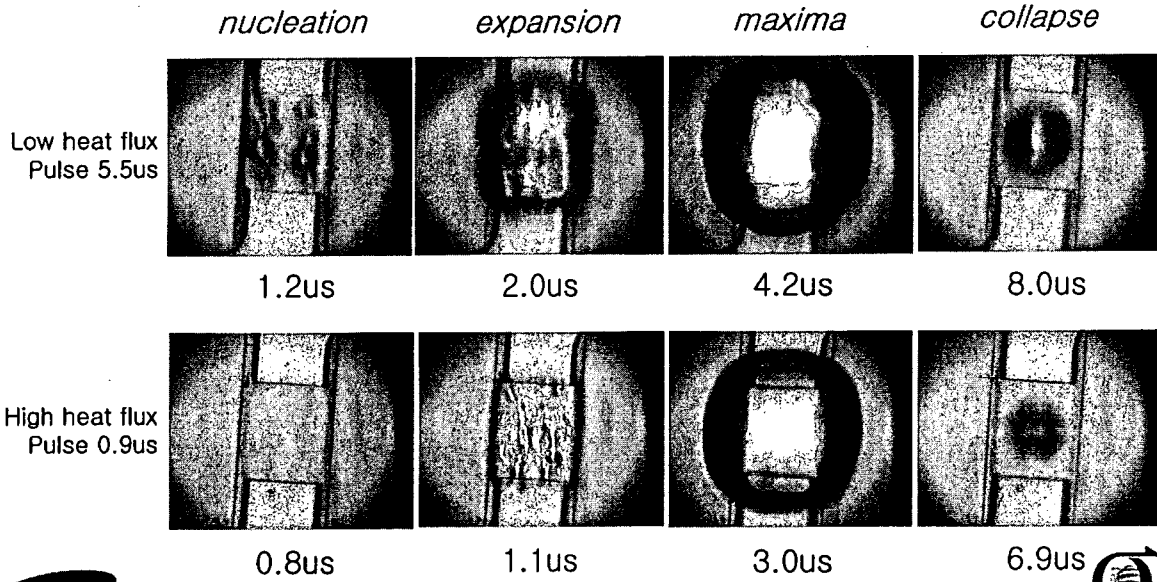
## Sample Preparation



# Open Pool Heater Experiment

## Heater Shape Variation

- Square Heater



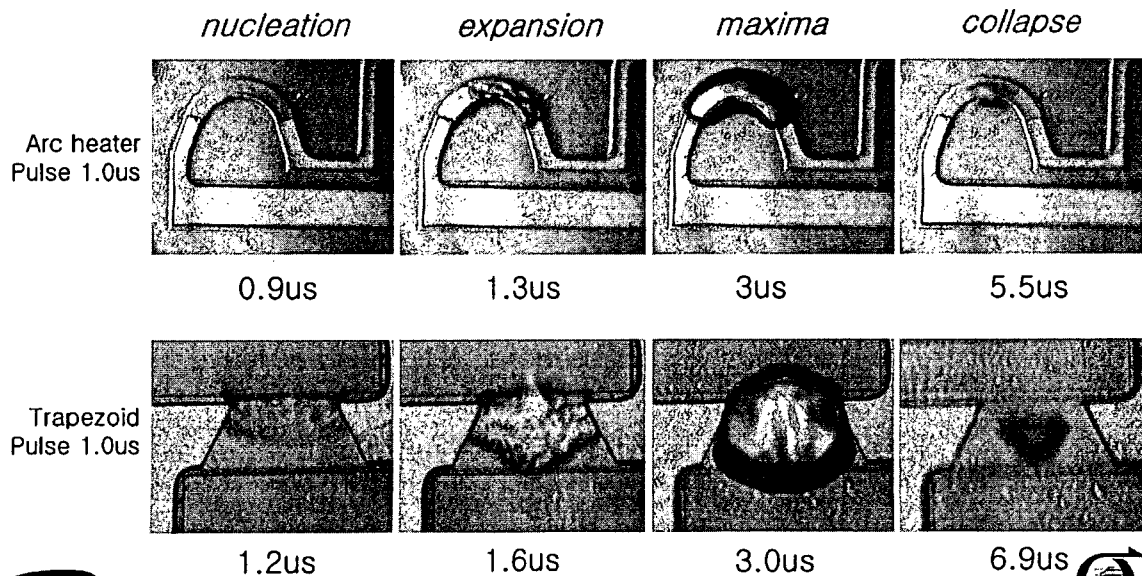
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# Open Pool Heater Experiment

## Heater Shape Variation

- High heat flux

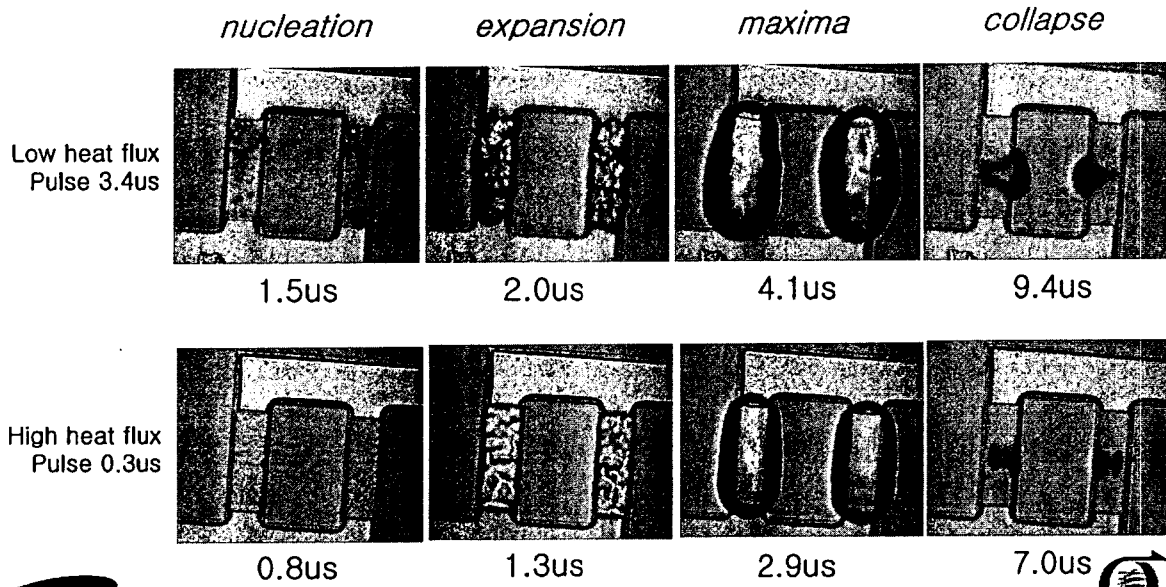


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# Open Pool Heater Experiment

## Twin Heater



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# Open Pool Heater Experiment

## Heater Shape Variation

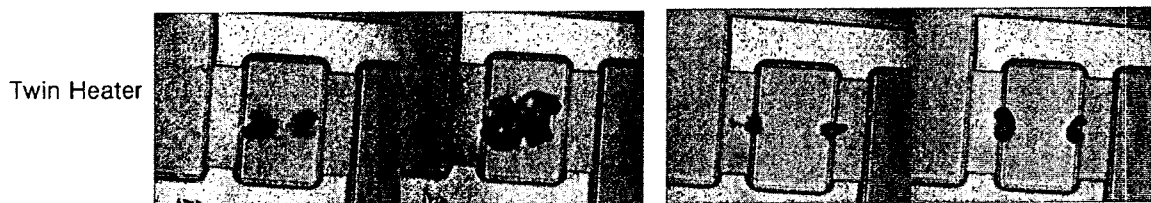
- Cavitation and Secondary Bubbles



Square

Arc

Trapezoid



Low Power  
Pulse 3.4us

High Power  
Pulse 0.3us



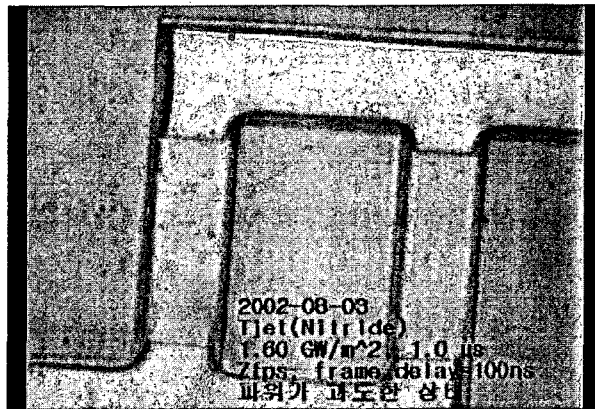
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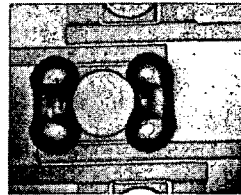
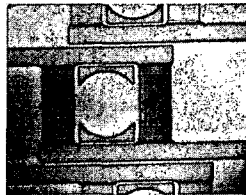


# Open Pool Heater Experiment

## Twin Heater



Cavitation Erosion



Bubble Shape After Erosion

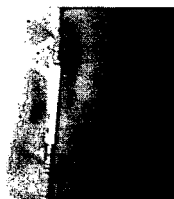
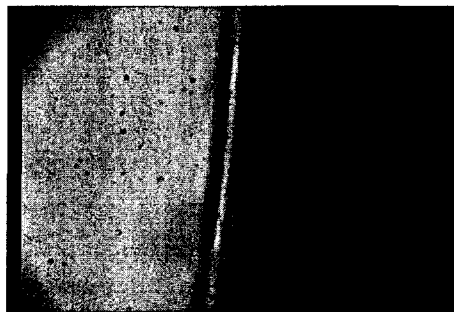


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# Open Pool Heater Experiment

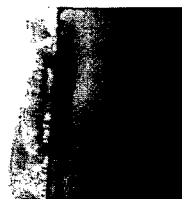
## Side View



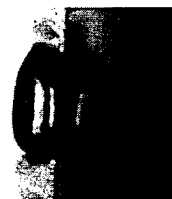
0.0us



1.2us



1.9us



5.6us



8.6us

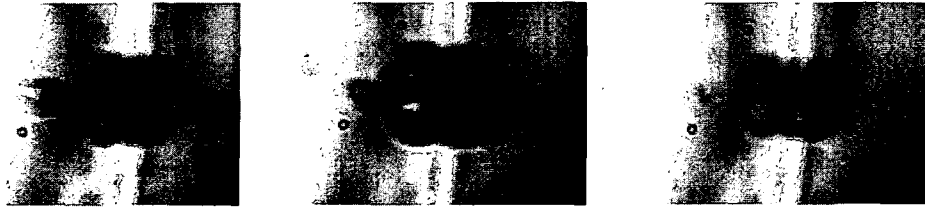


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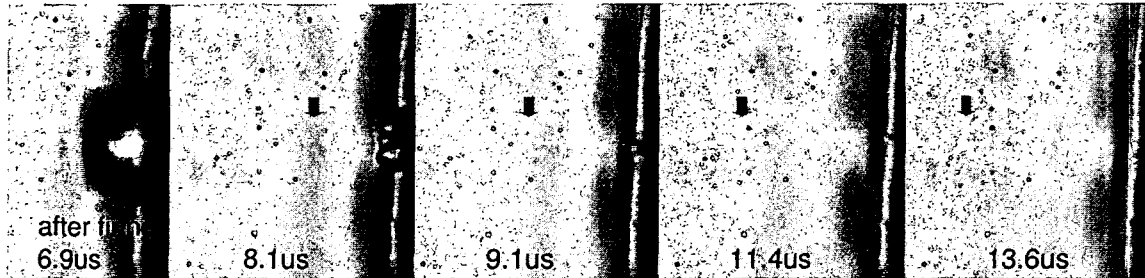


# Open Pool Heater Experiment

## Side View - Cavitation



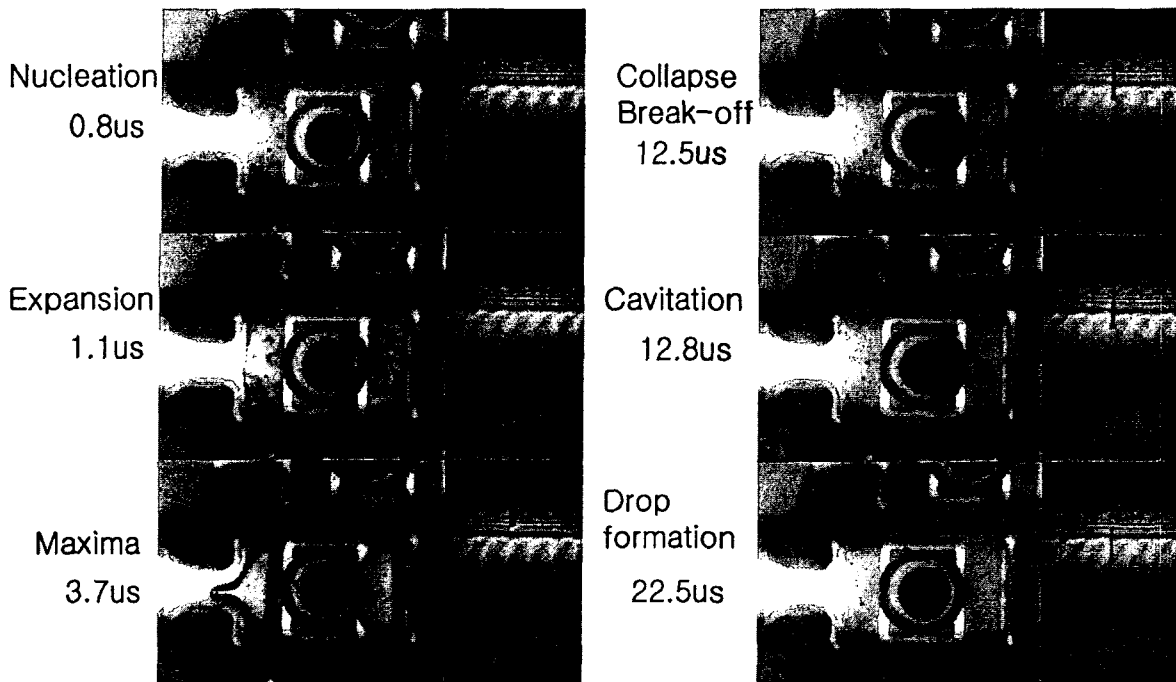
Cavitation induced secondary liquid jet



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## Ink Jet head Visualization



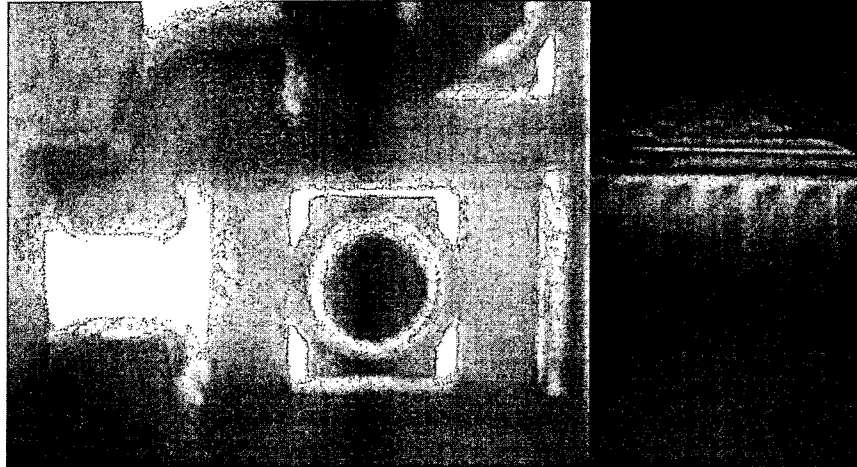
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# Ink Jet head Visualization

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Input Voltage : 13V  
Input Pulse Width: 1.1 $\mu$ s  
Input Power : 55 $\mu$ J  
Pulse Frequency : 1kHz



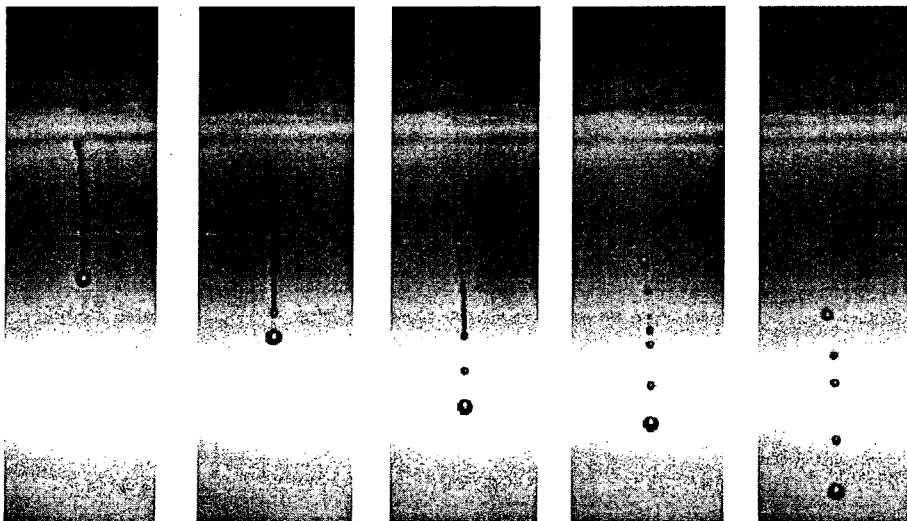
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# Ink Jet head Visualization

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Drop Formation - Rayleigh Instability



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## Future Work

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Meniscus Movement (Interferometer)

Thermal Imaging (Micro IR Camera)

Flow Field Measurement (PIV)



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