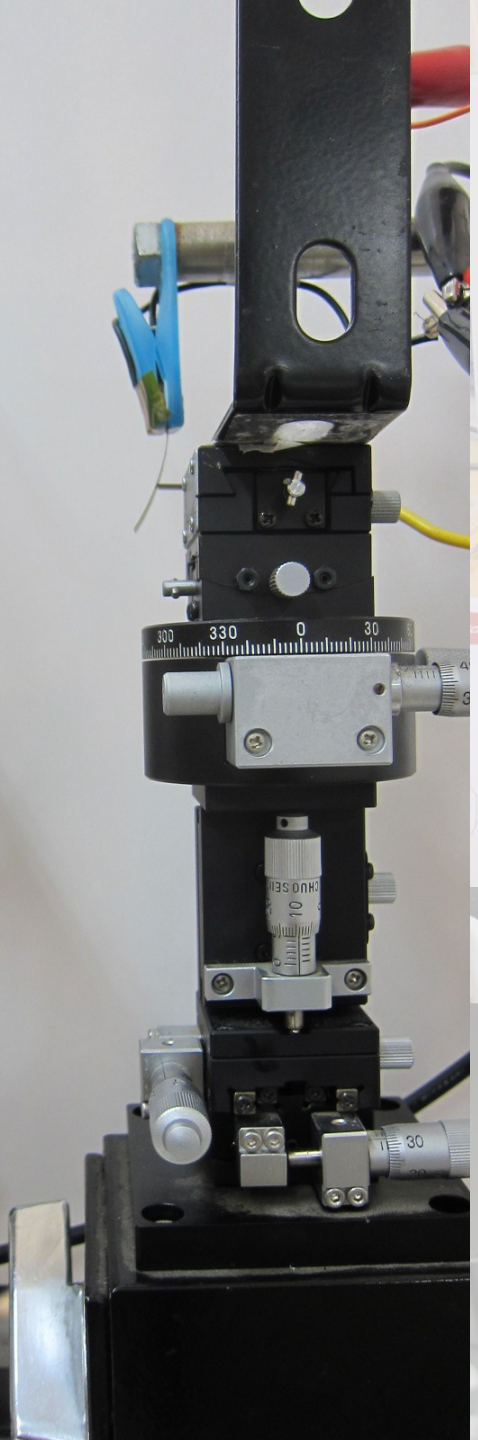


Proposal of a novel method for oscillating IPMCs with DC input

Louise Penna Poubel
07T0435F

February 18th, 2011
Chiba University

Outline

1. Background

2. Novel method / Objectives

3. Experimental setup

4. Results and discussion
   - 4.1. Confirmation of oscillation
   - 4.2. Oscillation types
   - 4.3. Comparison with an AC system

5. Conclusion

Outline

1. Background

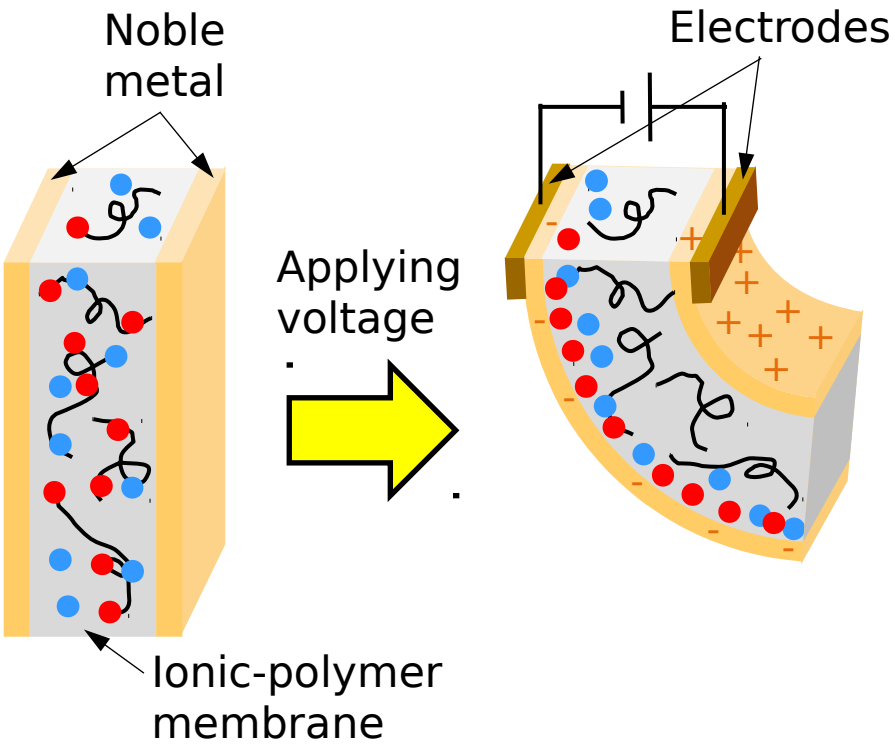
2. Novel method / Objectives

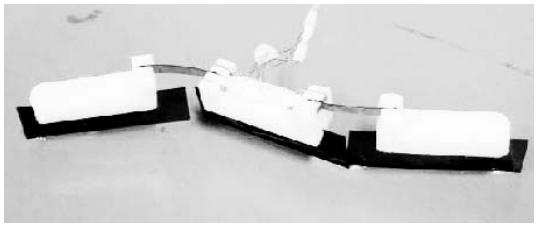
3. Experimental setup

4. Results and discussion
   - 4.1. Confirmation of oscillation
   - 4.2. Oscillation types
   - 4.3. Comparison with an AC system

5. Conclusion

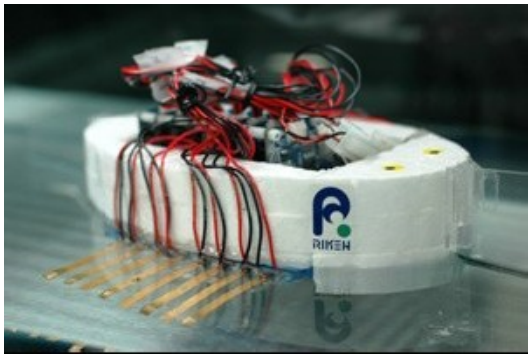
1. IPMC's actuation and current usage





Snake-like robot

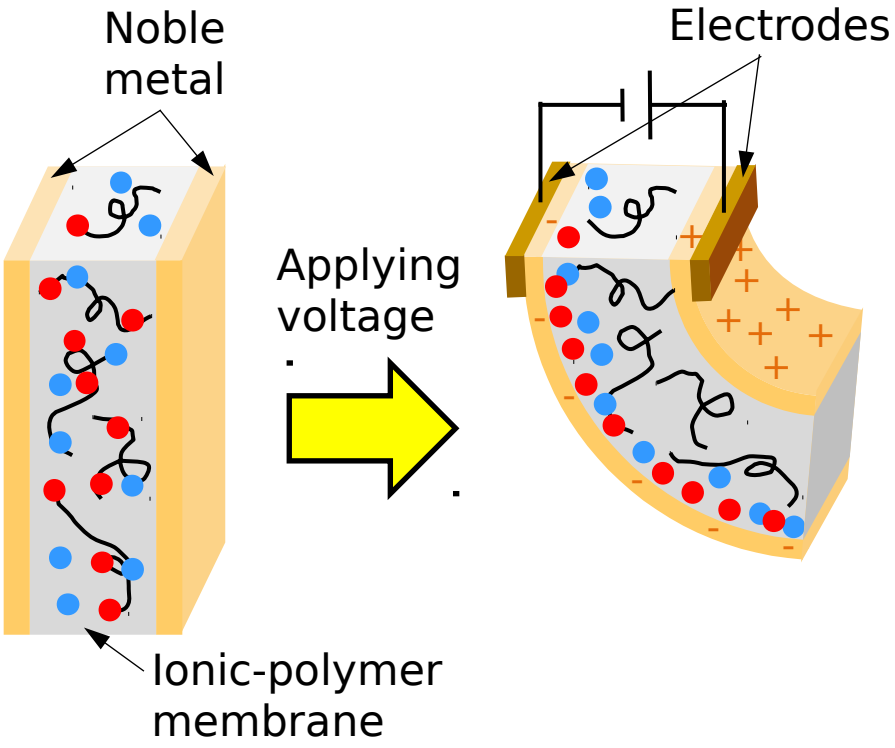
N. Kamamichi et al., 2006

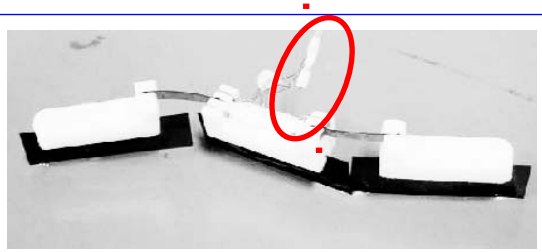


Rajiform robot

K. Takagi et al., 2006

1. IPMC's actuation and current usage

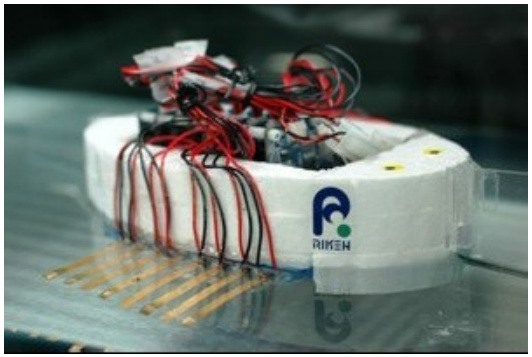




Wire connections

Snake-like robot

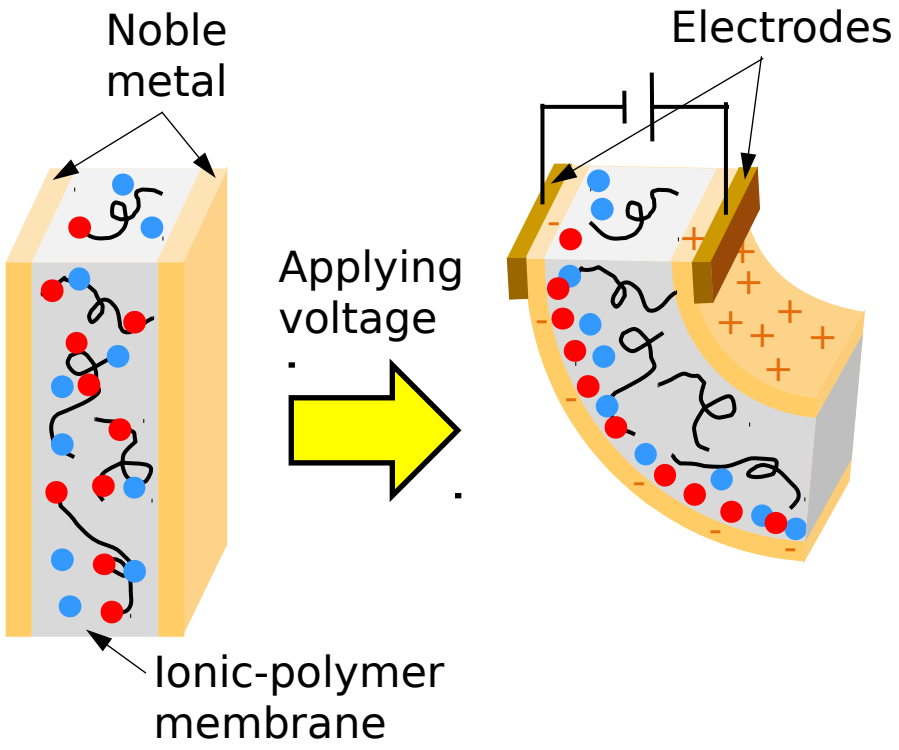
N. Kamamichi et al., 2006

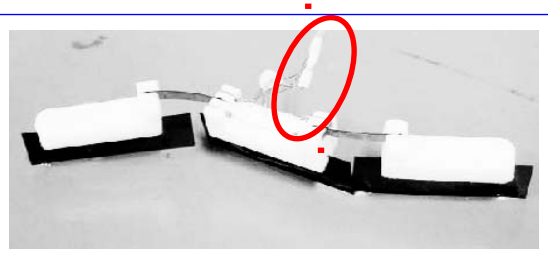


Rajiform robot

K. Takagi et al., 2006

1. IPMC's actuation and current usage

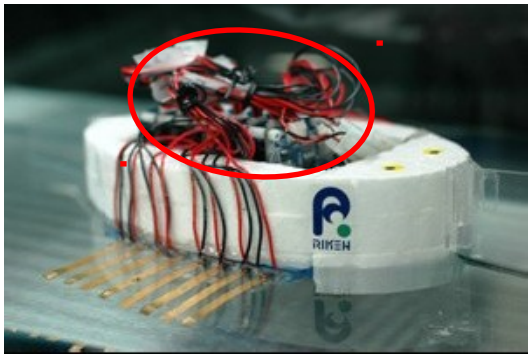




Snake-like robot

N. Kamamichi et al., 2006

Wire connections

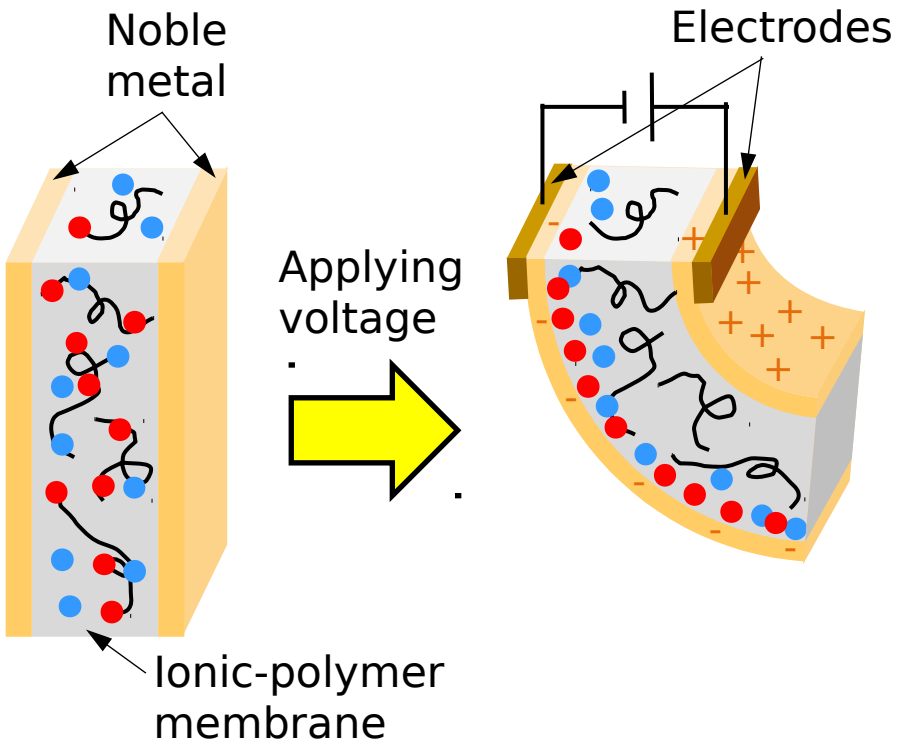


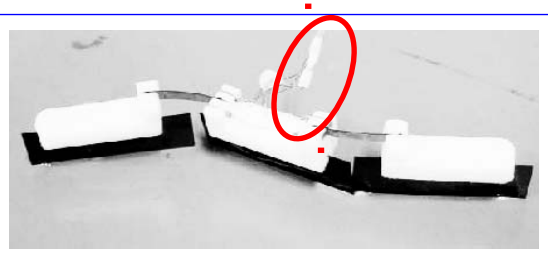
Rajiform robot

K. Takagi et al., 2006

Bulky electronics

1. IPMC's actuation and current usage

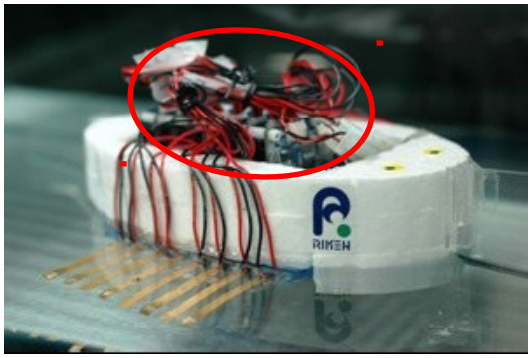




Snake-like robot

N. Kamamichi et al., 2006

Wire connections



Rajiform robot

K. Takagi et al., 2006

Bulky electronics

Electrodes are always fixed to the IPMC

Outline

1. Background

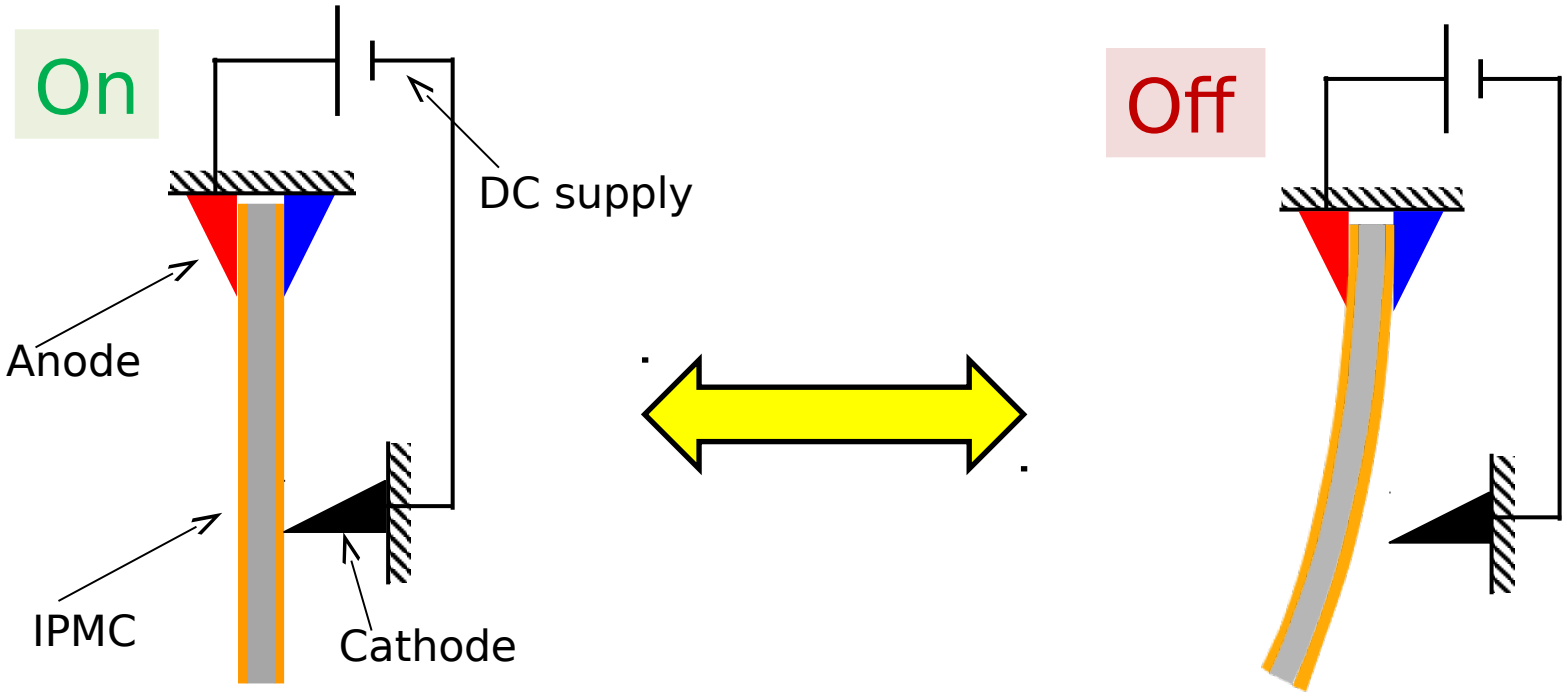
2. Novel method / Objectives

3. Experimental setup

4. Results and discussion
   - 4.1. Confirmation of oscillation
   - 4.2. Oscillation types
   - 4.3. Comparison with an AC system

5. Conclusion

2. Novel method



- Anode fixed to the left surface
- Cathode touching the right surface
- Potential across the actuator
- Bending towards the anode

- Anode fixed to the left surface
- Cathode loses contact
- No potential across the actuator
- Return to equilibrium

2. Objectives

1. Check if it is possible to obtain oscillation from a DC input using the actuator's own movement to switch itself on and off.

2. Observe the characteristics of the oscillation obtained for different cathode positions.

3. Compare the new system with an AC oscillatory system.

Outline

1. Background

2. Novel method / Objectives

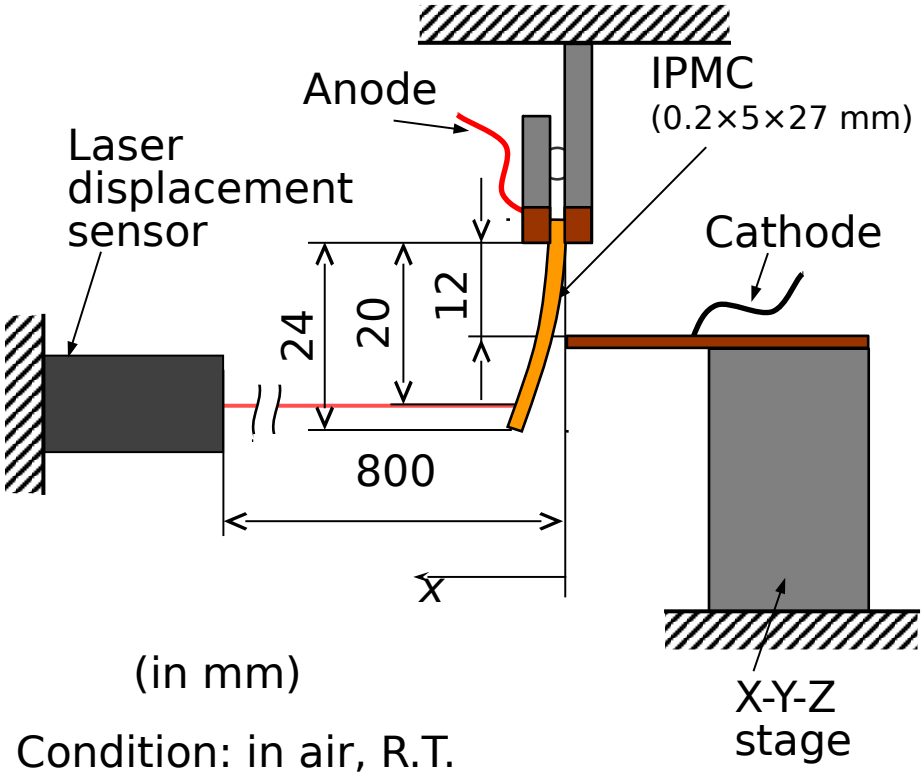
3. Experimental setup

4. Results and discussion
   - 4.1. Confirmation of oscillation
   - 4.2. Oscillation types
   - 4.3. Comparison with an AC system

5. Conclusion

3. Experimental (oscillation)

Procedure:
1)Press cathode until desired position
(0.7 mm to 3.1 mm)
1)Apply voltage (3 V)



Condition: in air, R.T.

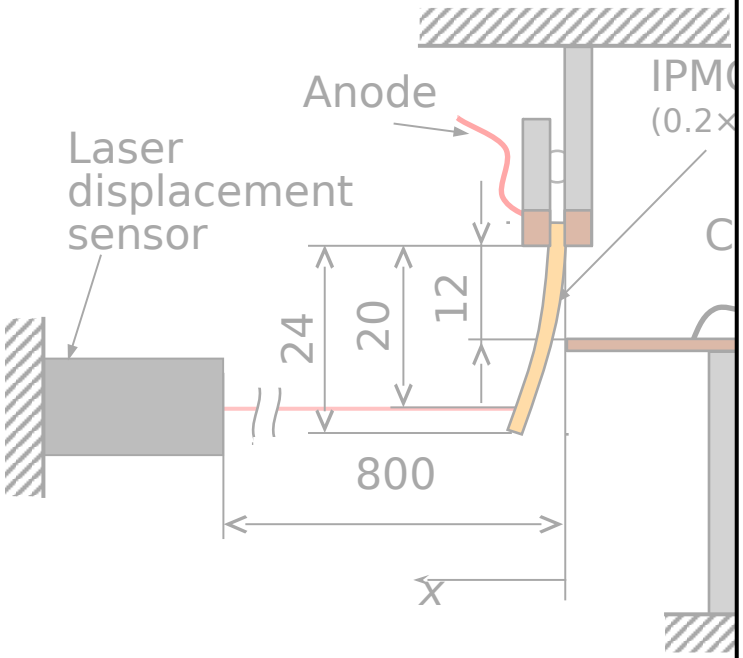
Fig. 1 Diagram of the oscillation measurement system.

3. Experimental (oscillation)

Procedure:

1)Press cathode until desired pos
(0.7 mm to 3.1 mm)

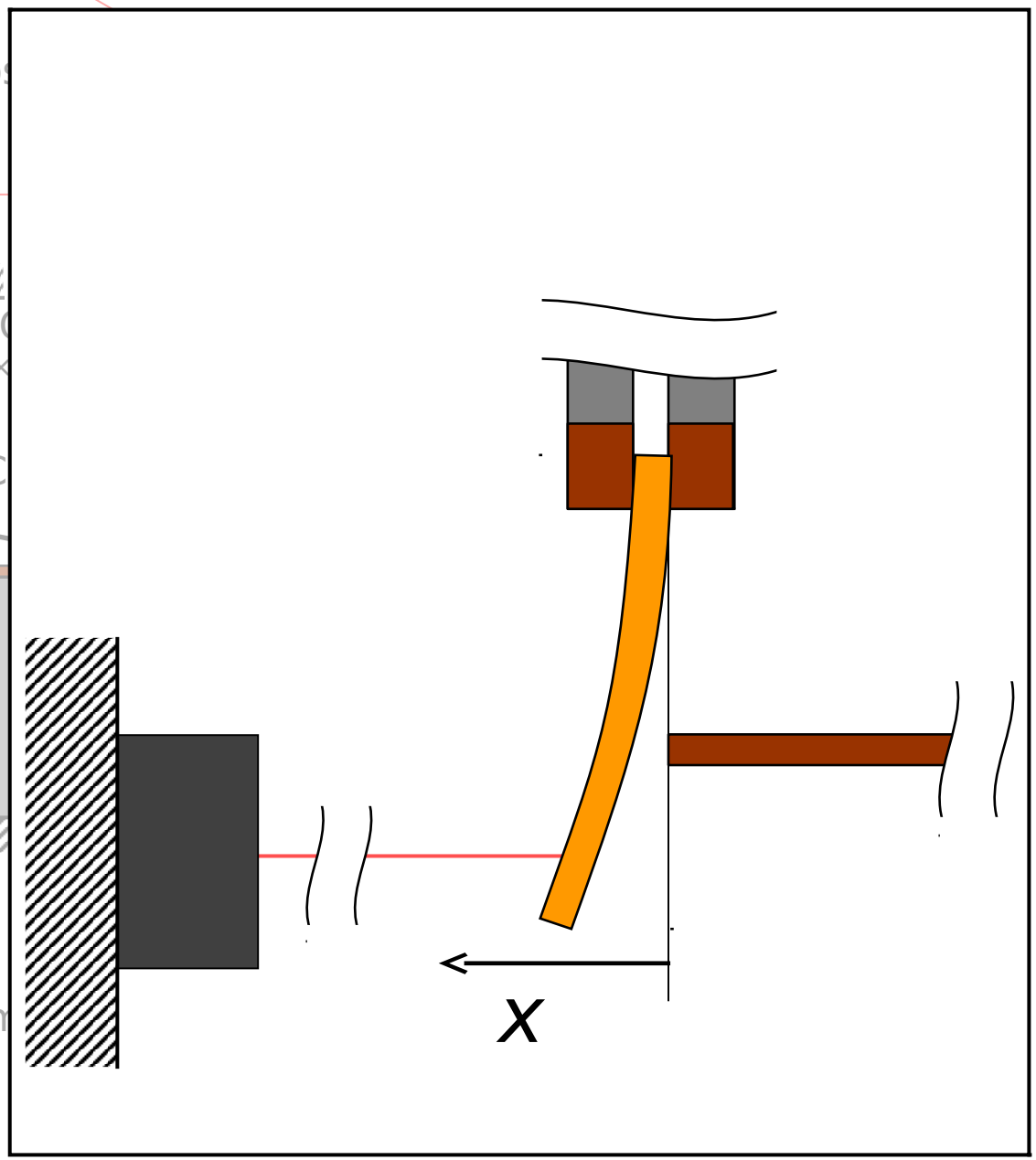
1)Apply voltage (3 V)



(in mm)

Condition: in air, R.T.

Fig. 1 Diagram of the oscillation m

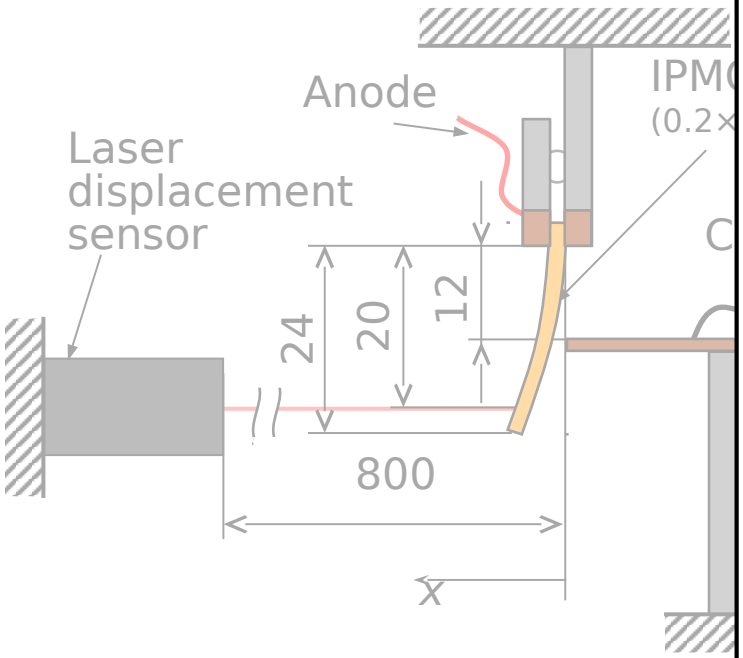


3. Experimental (oscillation)

Procedure:

1)Press cathode until desired pos
(0.7 mm to 3.1 mm)

1)Apply voltage (3 V)

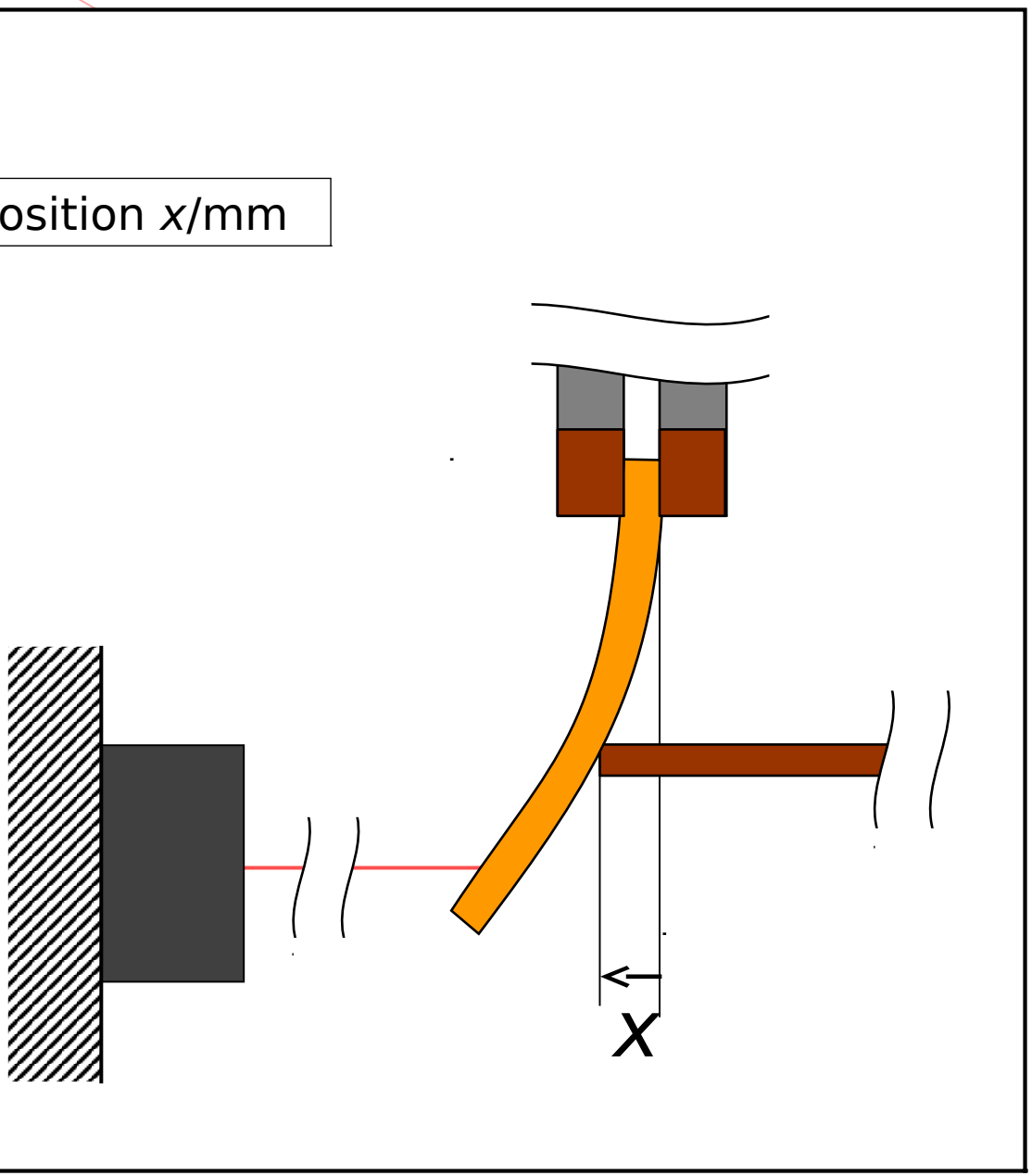


(in mm)

Condition: in air, R.T.

Fig. 1 Diagram of the oscillation m

Cathode position *x*/mm



3. Experimental (oscillation)

Procedure:

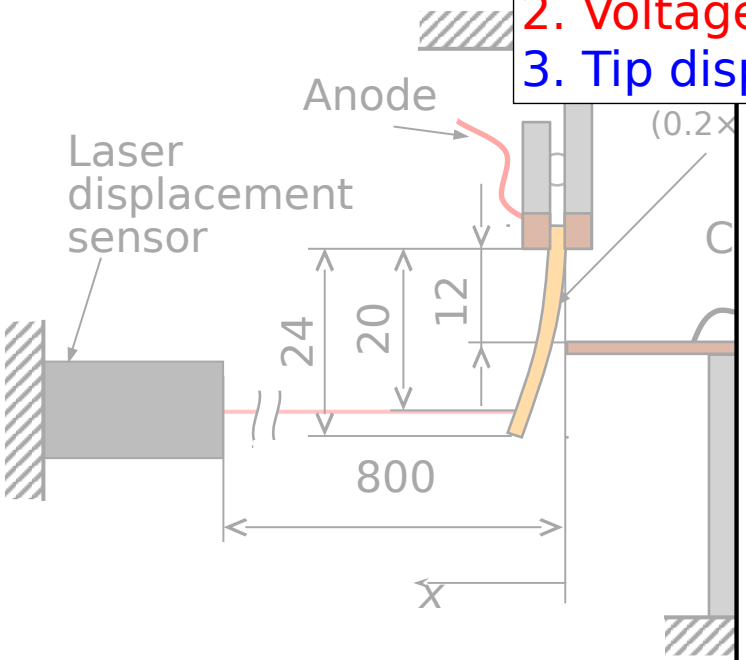
1)Press cathode until desired pos
(0.7 mm to 3.1 mm)

1)Apply voltage (3 V)

1.Input voltage *E*/V

2. Voltage across IPMC *V*/V

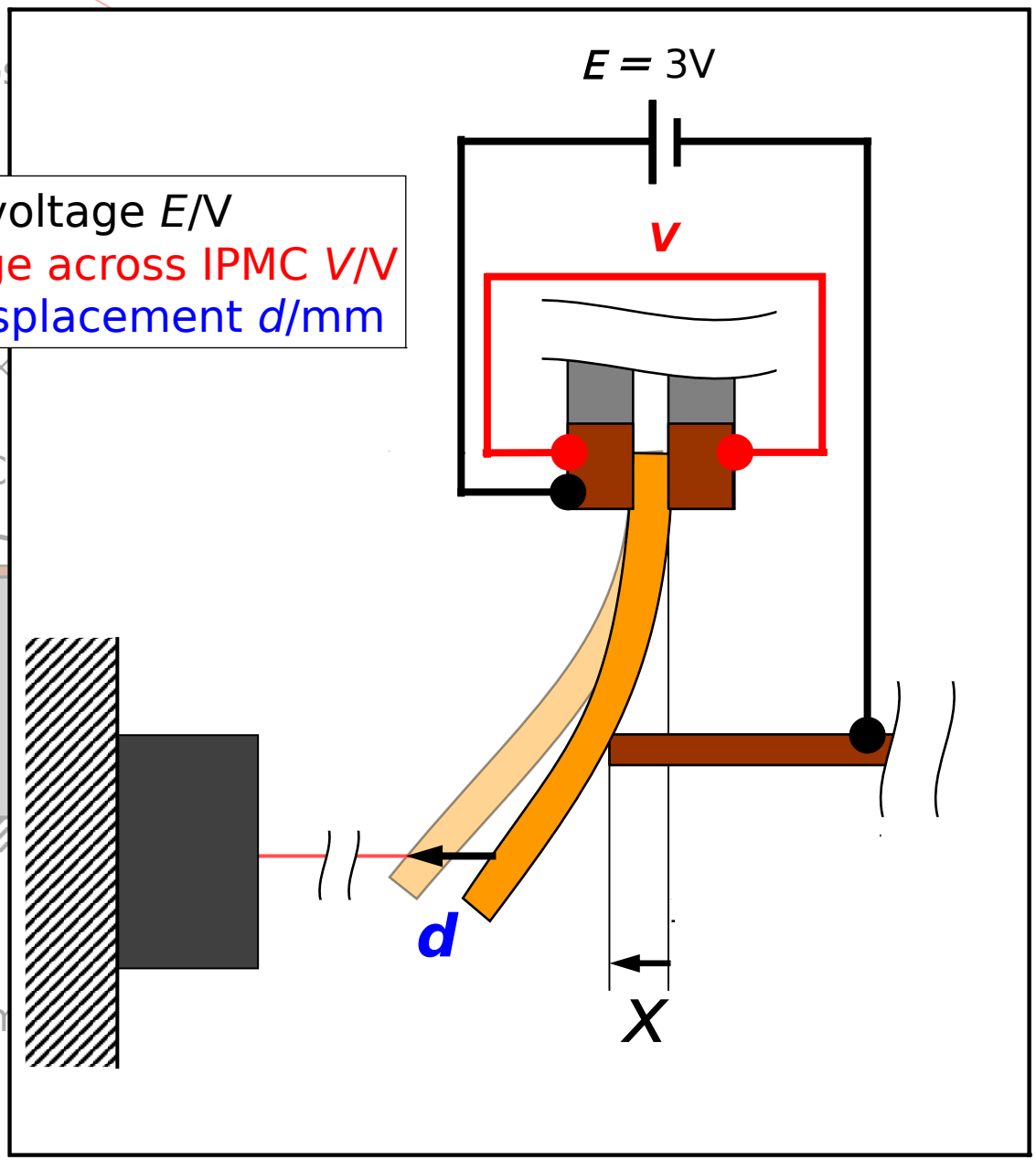
3. Tip displacement *d*/mm



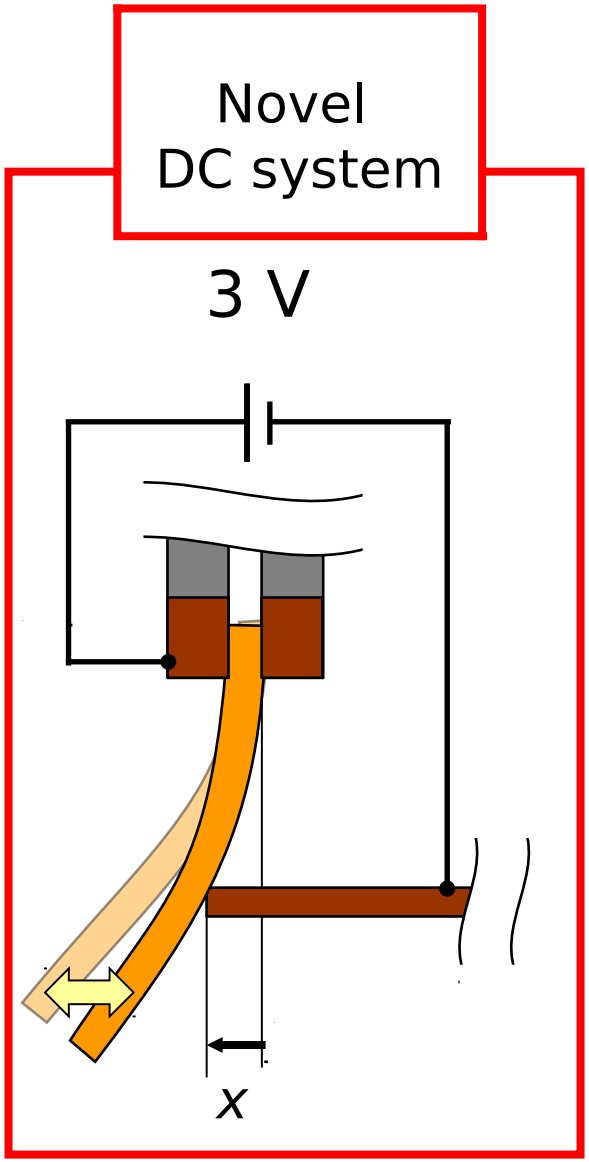
(in mm)

Condition: in air, R.T.

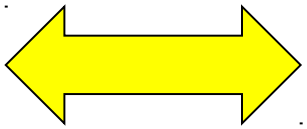
Fig. 1 Diagram of the oscillation m

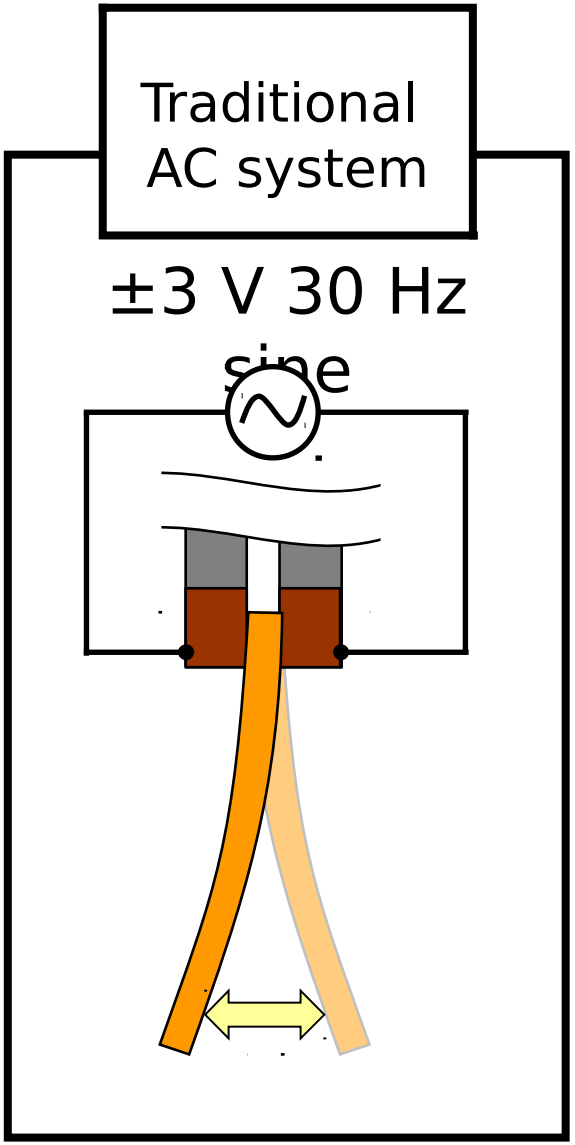


3. Experimental (Comparison)



Comparison





Outline

1. Background

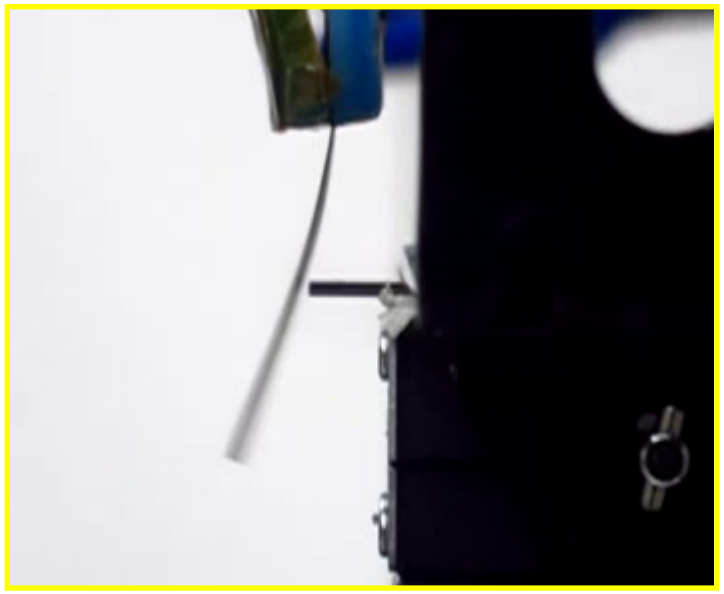
2. Novel method / Objectives

3. Experimental setup

4. Results and discussion
   - 4.1. Confirmation of oscillation
   - 4.2. Oscillation types
   - 4.3. Comparison with an AC system

5. Conclusion

4.1. Confirmation of oscillation



Video: x = 2.3 mm

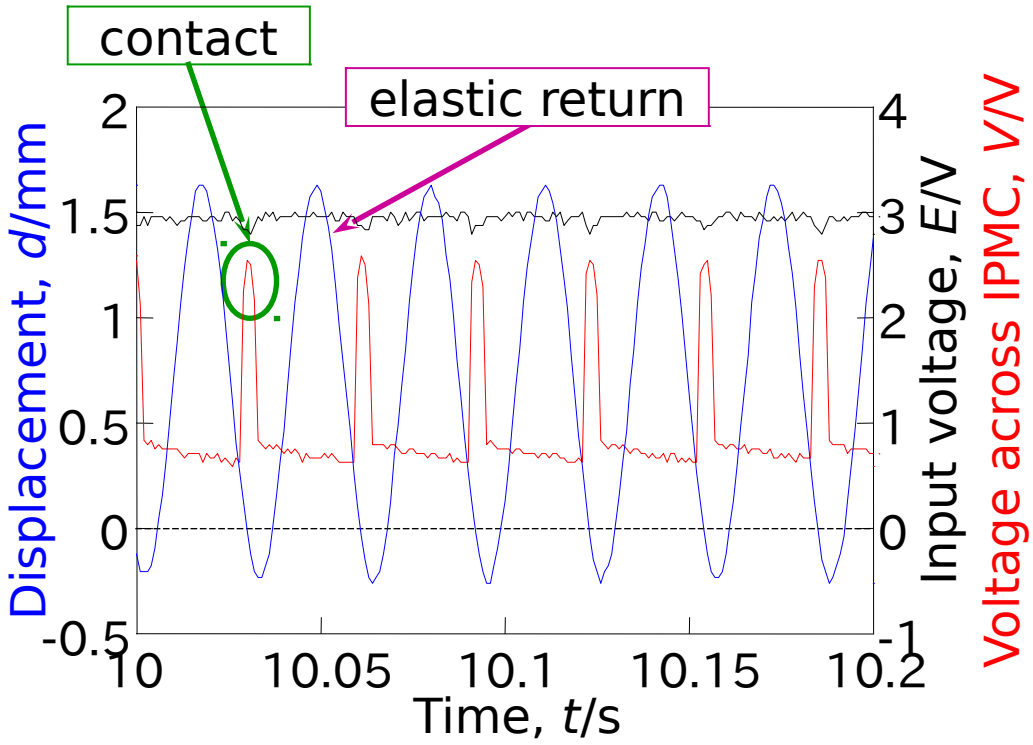
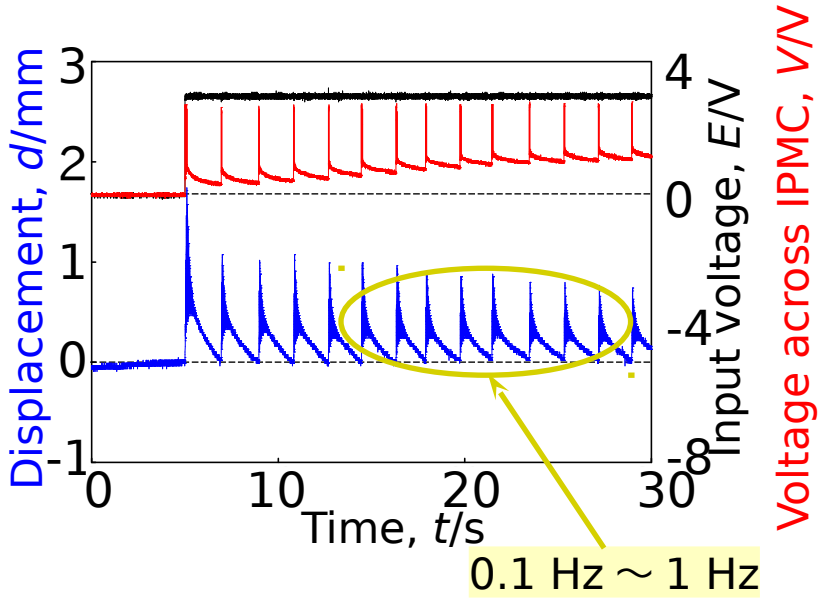


Fig. Tip displacement and voltage across IPMC (x = 2.3 mm).

1) Oscillation was achieved.
2) Peaks in voltage show when there's contact.
3) Electrical and mechanical forces alternate in oscillation.

4.2. Oscillation types

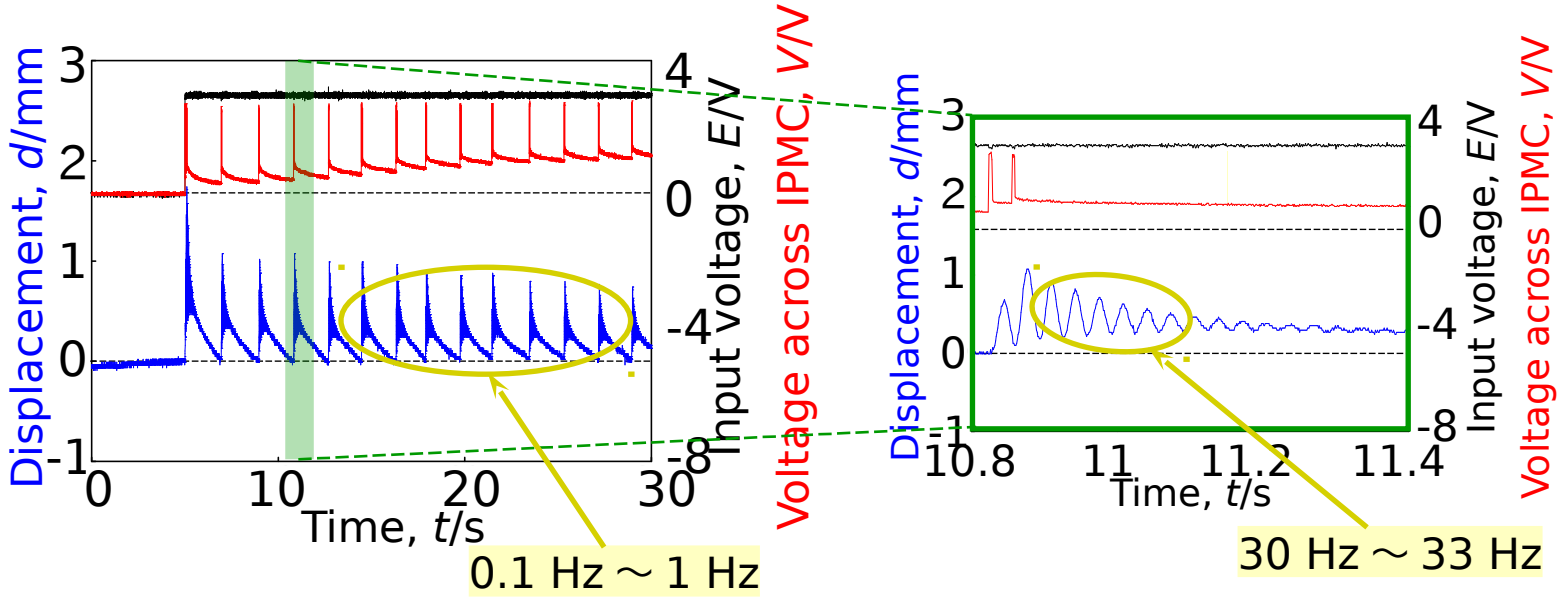
Cathode position (x/mm)
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
2.7
2.9
3.1



There are two main types of oscillation.

4.2. Oscillation types

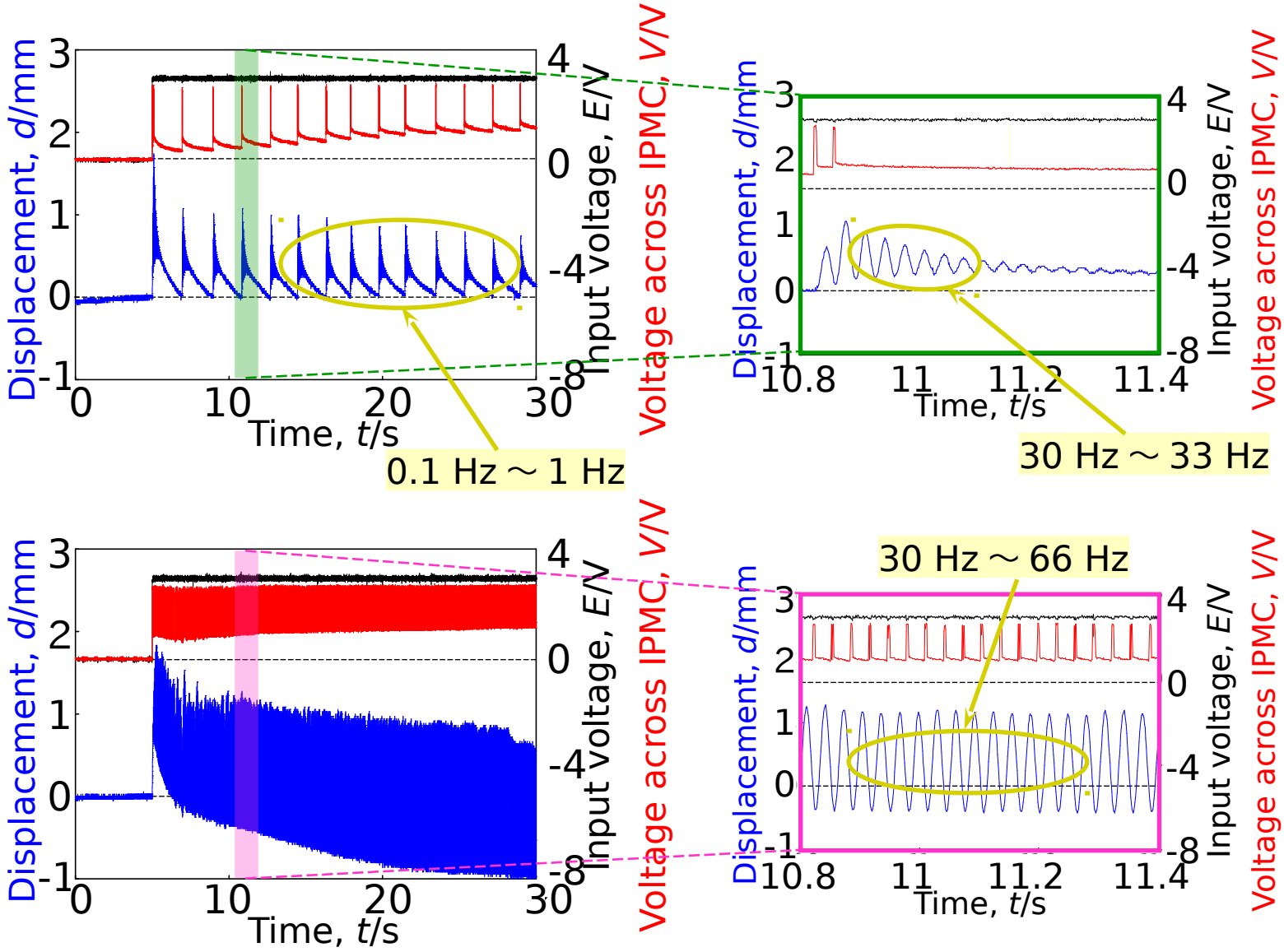
Cathode position (x/mm)
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
2.7
2.9
3.1



There are two main types of oscillation.

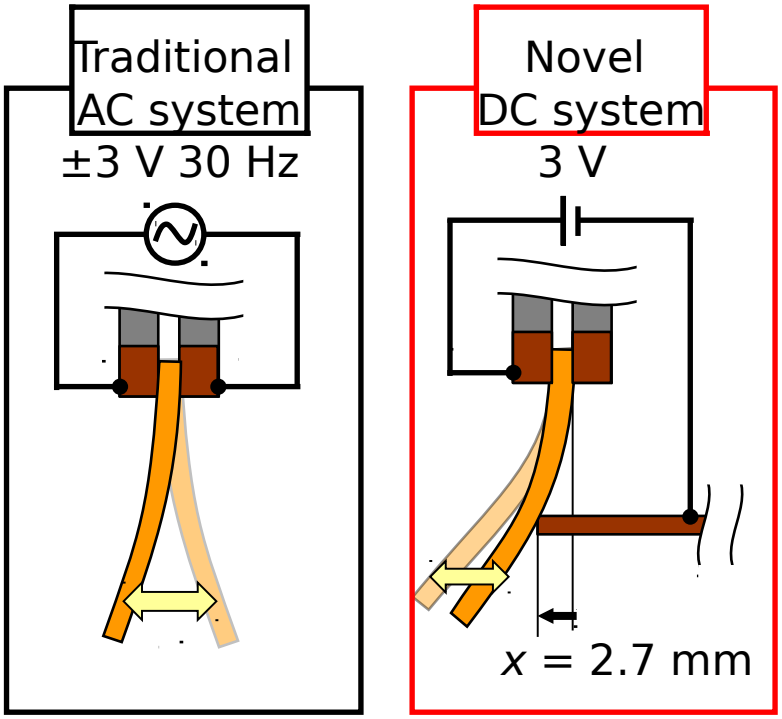
4.2. Oscillation types

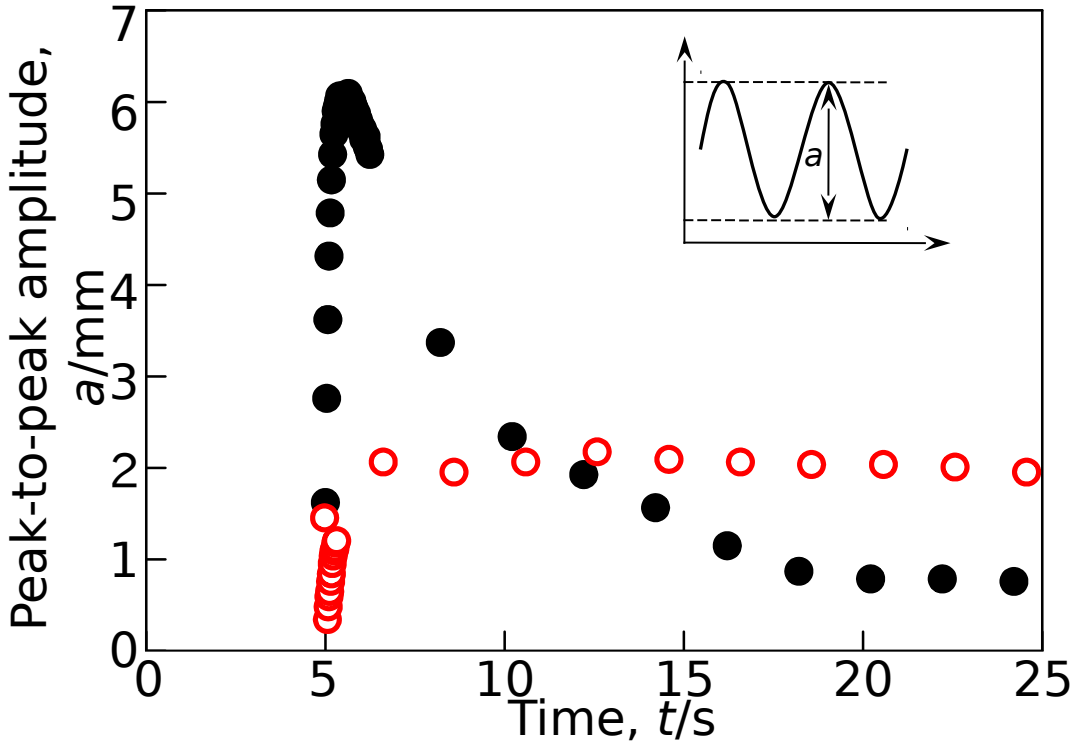
Cathode position (x/mm)
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
2.7
2.9
3.1



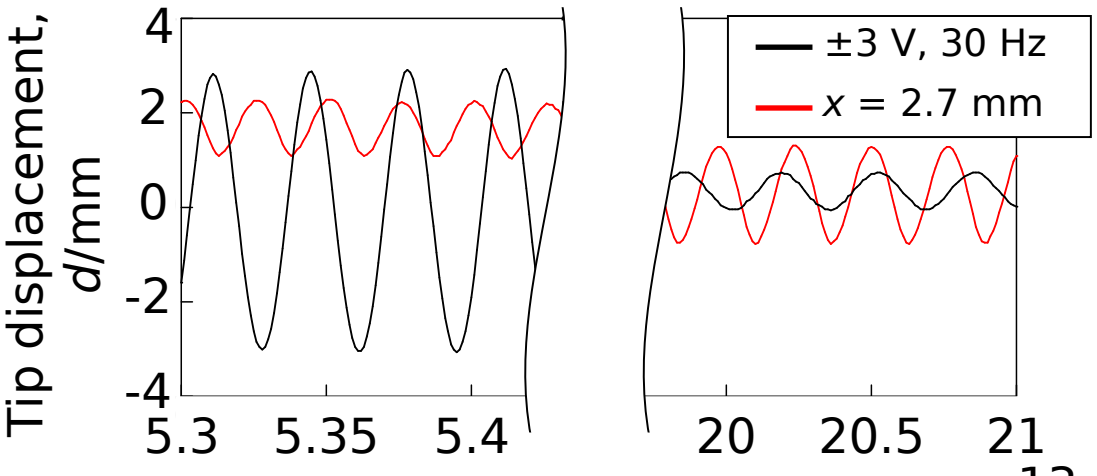
There are two main types of oscillation.

4.3. Comparison with an AC system





1) The novel system oscillates in amplitudes comparable to those of an AC system
2) The novel system is more stable under these conditions



Outline

1. Background

2. Novel method / Objectives

3. Experimental setup

4. Results and discussion
   - 4.1. Confirmation of oscillation
   - 4.2. Oscillation types
   - 4.3. Comparison with an AC system

5. Conclusion

5. Conclusions

1. It was confirmed that oscillation can be obtained from a DC input using the novel system proposed.

2. The cathode position affects the type of oscillation and its characteristics.

3. Oscillations obtained with the new system achieved amplitudes comparable to an AC system and were more stable.

Obrigada pela atenção!

Experimental setup - specimen

Ionic polymer: Nafion
Metal: Gold
Counter ion: Na^+

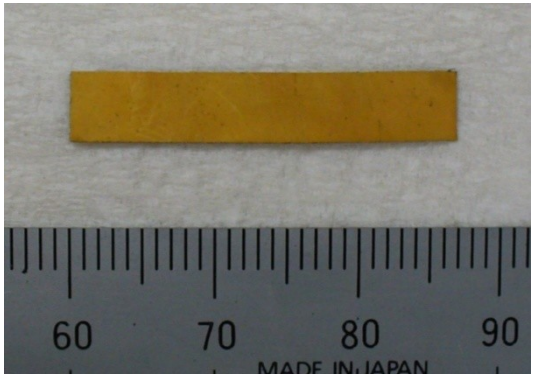
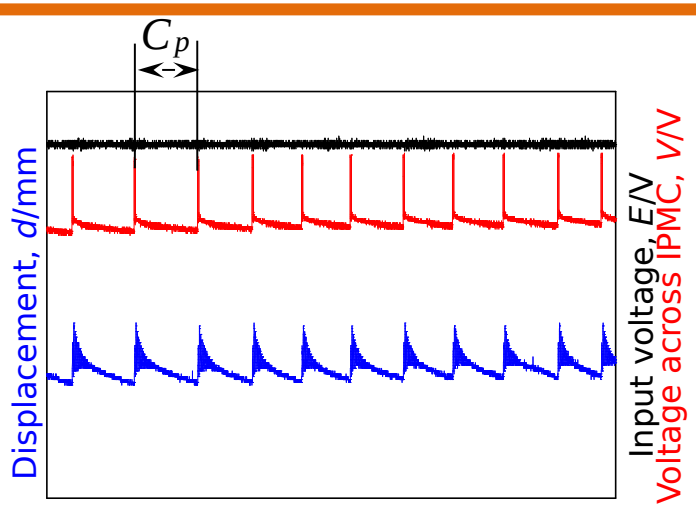


Fig. Overview

Table Size of the specimen

Width, *b*/mm	**Length, *l*/mm**	**Thickness, *t*/mm**
5	**27**	**0.2**

Cyclic oscillation frequency



$$f_{cy} = \frac{1}{C_p}$$

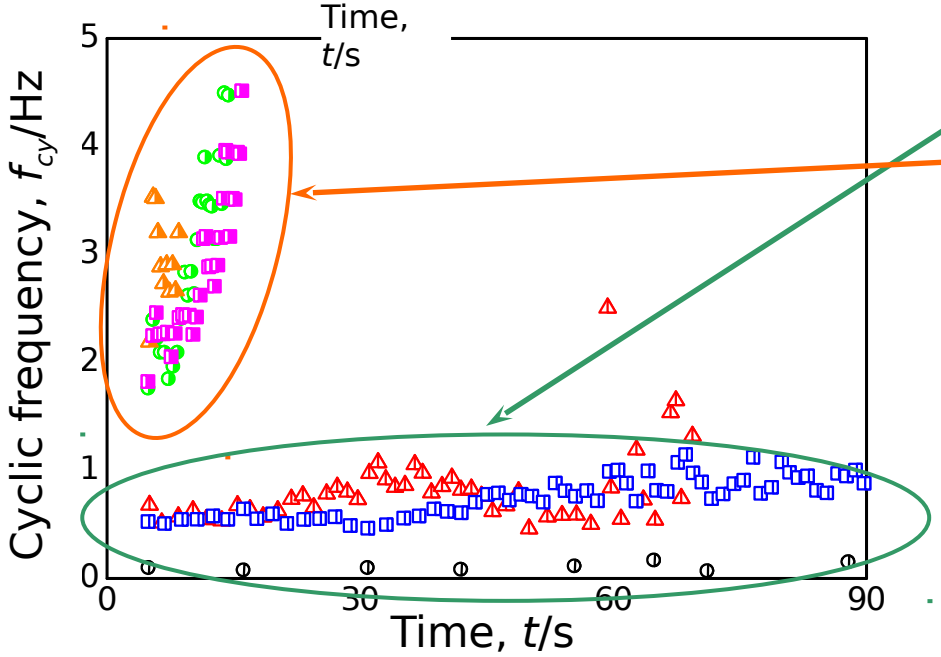
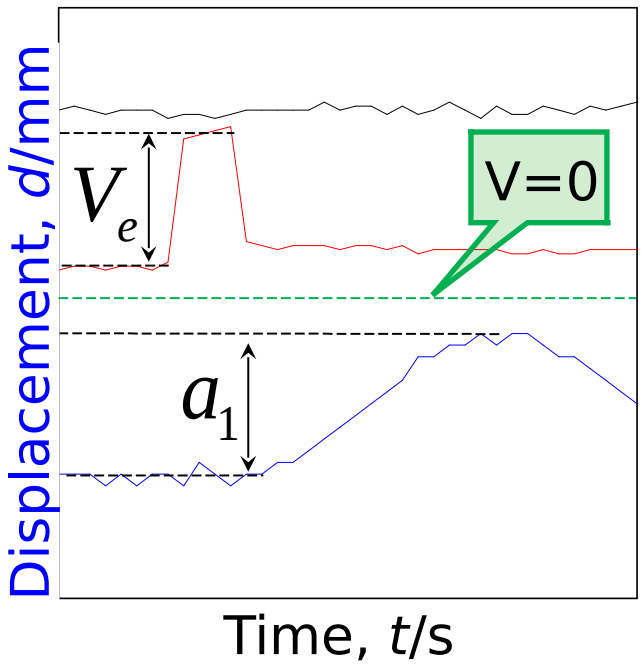


Table 3.1 Types of oscillation per cathode position

Cathode position (mm)	Symbol	Cyclic oscillation	Continuous oscillation
0.7		☑	☐
0.9		☑	☐
1.1		☑	☐
1.3		☑	☑
1.5		☑	☑
1.7		☑	☑
1.9		☐	☑
2.1		☐	☑
2.3		☐	☑
2.5		☐	☑
2.7		☐	☑
2.9		☐	☑
3.1		☐	☑

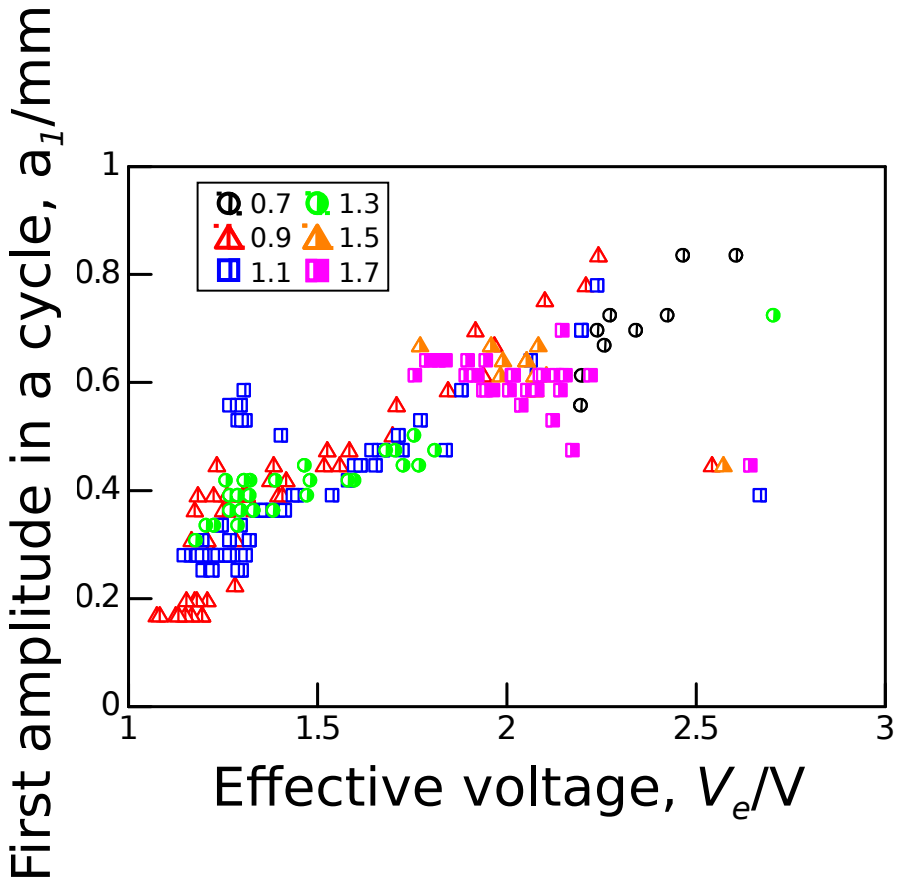
The cyclic frequency for positions which transition increase quickly and for those which don't, slowly

Voltage and amplitude



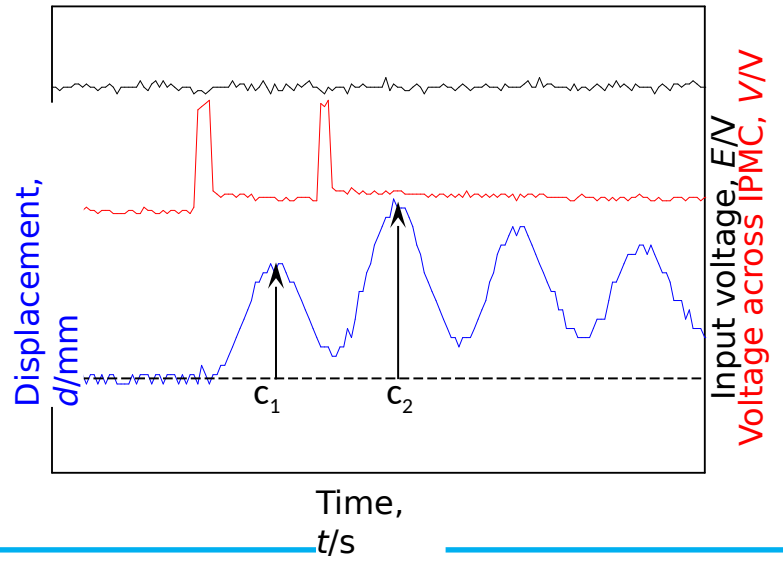
Input voltage, *E*/V

Voltage across IPMC, *V*/V



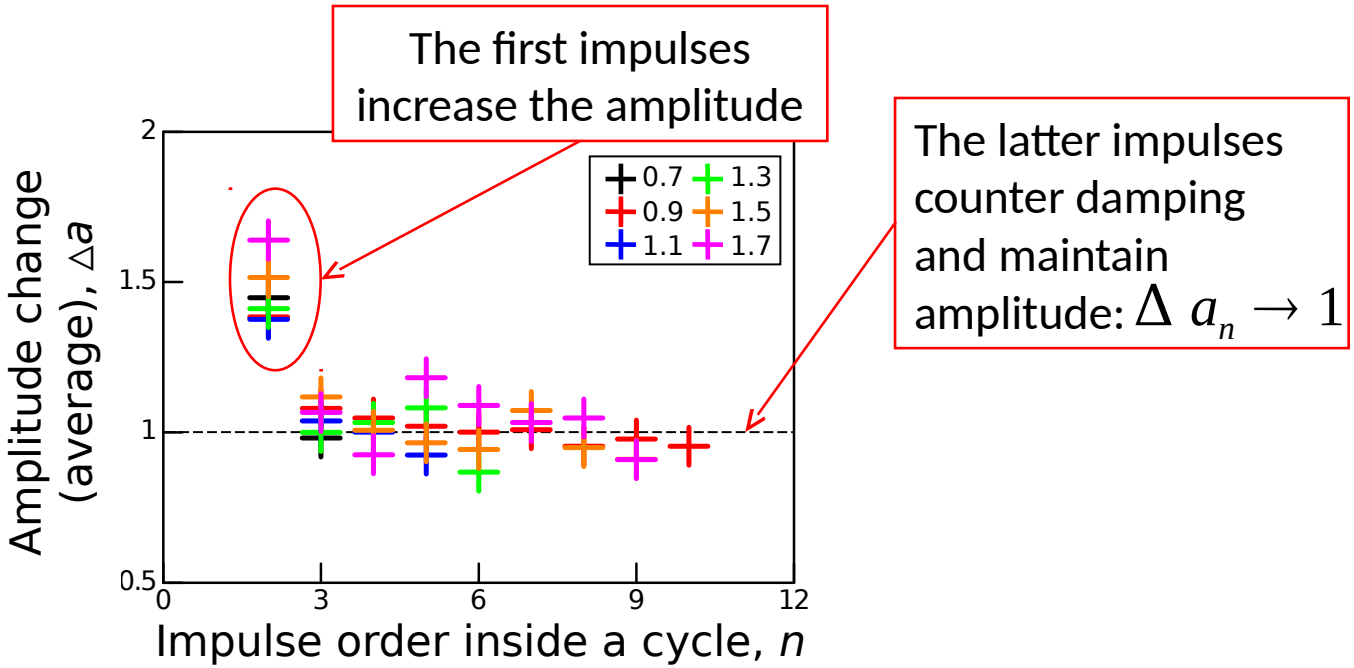
The first amplitude in a cycle increases with the effective voltage independently of cathode position

Amplitude change

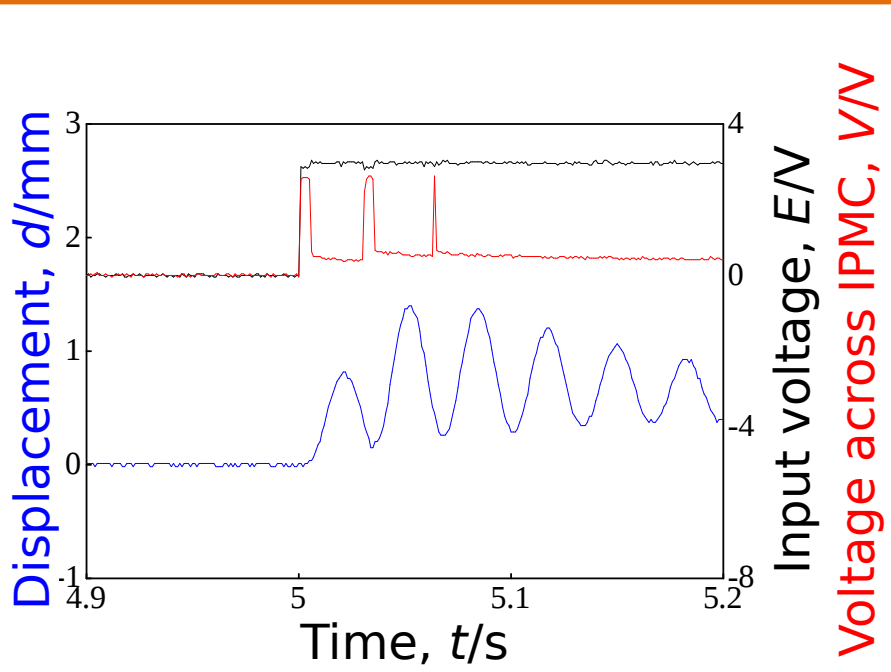


The amplitude change between pulses is shown as:

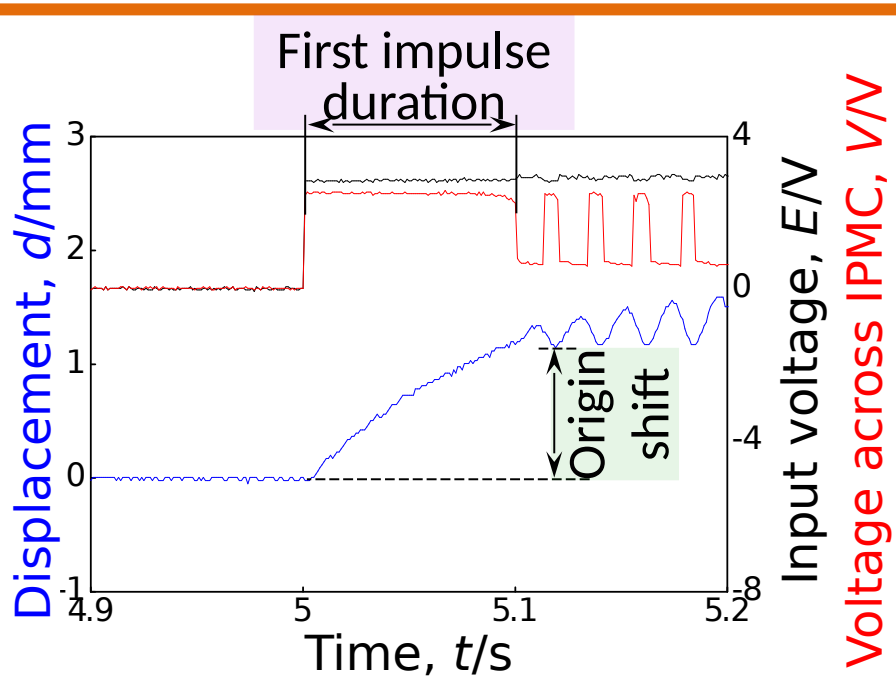
$$\Delta a_n = \frac{c_n}{c_{n-1}}$$



Initial response

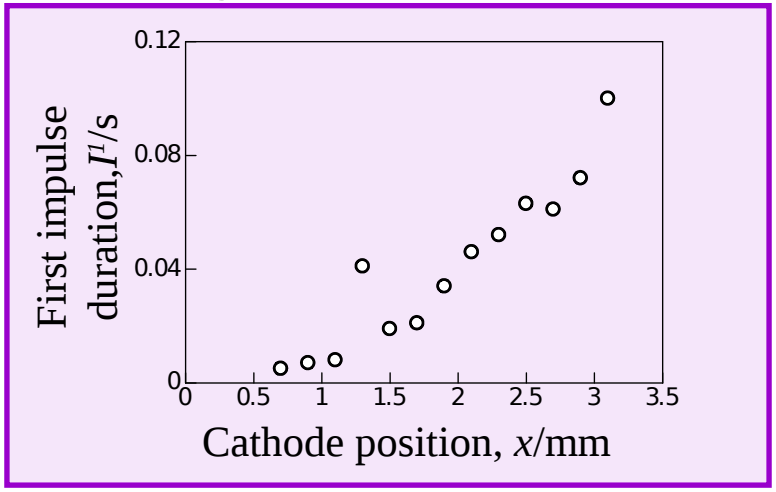


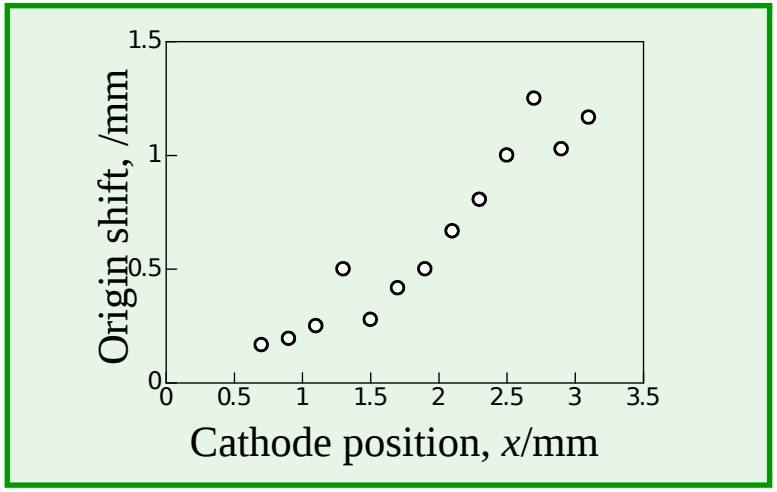
(a) x = 0.7 mm



(b) x = 3.1 mm

Fig. 2 Effects of cathode position on initial response





Transition

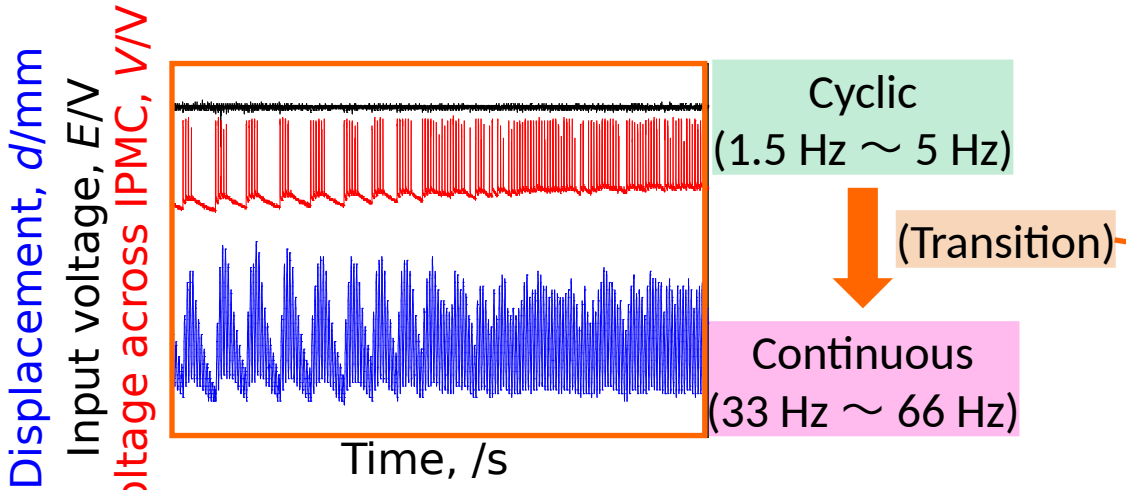


Table 3.1 Types of oscillation per cathode position

Cathode position (x/mm)	Cyclic oscillation	Continuous oscillation
0.7	☑	☐
0.9	☑	☐
1.1	☑	☐
1.3	☑	☑
1.5	☑	☑
1.7	☑	☑
1.9	☐	☑
2.1	☐	☑
2.3	☐	☑
2.5	☐	☑
2.7	☐	☑
2.9	☐	☑
3.1	☐	☑

There are two types of oscillation, cyclic and continuous.