

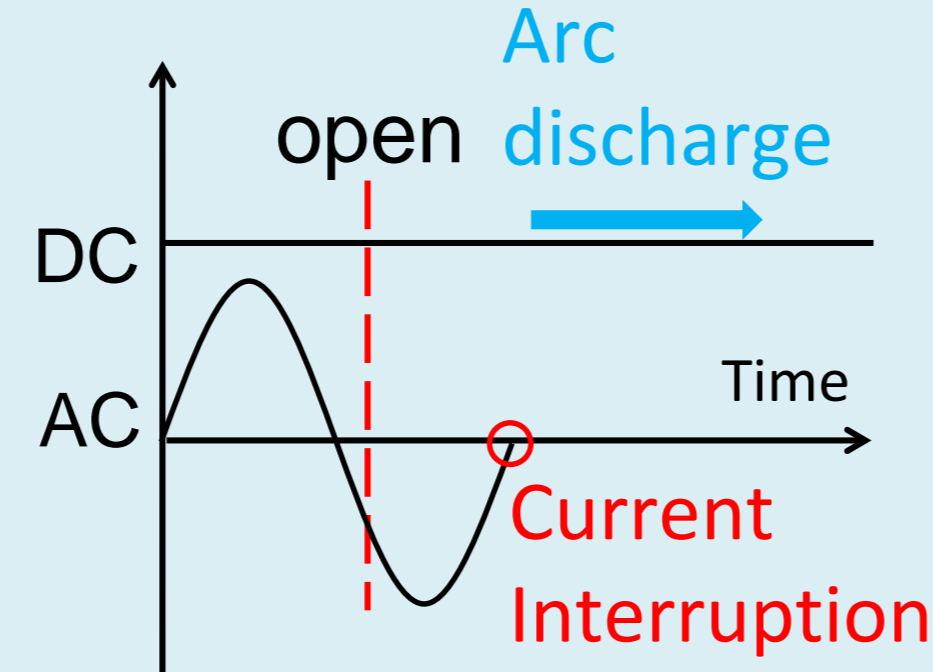
Development of an Arcless DC Circuit Breaker using a Mechanical Contact and a Semiconductor Device

Summary

Direct current circuit breakers (DCCBs) have received considerable attention due to their increasing demand in DC power transmission and distributed generation. A hybrid DCCB comprising a mechanical contact, semiconductor device (SiC-MOSFET), and metal oxide varistor offers a small contact resistance when the mechanical contact is closed. After opening the mechanical contact, the contact voltage increases because a molten metal bridge is formed between the contacts as a result of joule heating. This molten-bridge voltage promotes the current commutation from the mechanical contact to the SiC-MOSFET. After the current commutation is completed, a fast current interruption can be achieved by turning off the SiC-MOSFET. Therefore, the hybrid DCCB can achieve both a small contact resistance and a fast current interruption. We performed DC current (300 V-150 A) interruption experiment, and succeeded in obtaining arcless current interruption with a probability of 100%.

Back ground

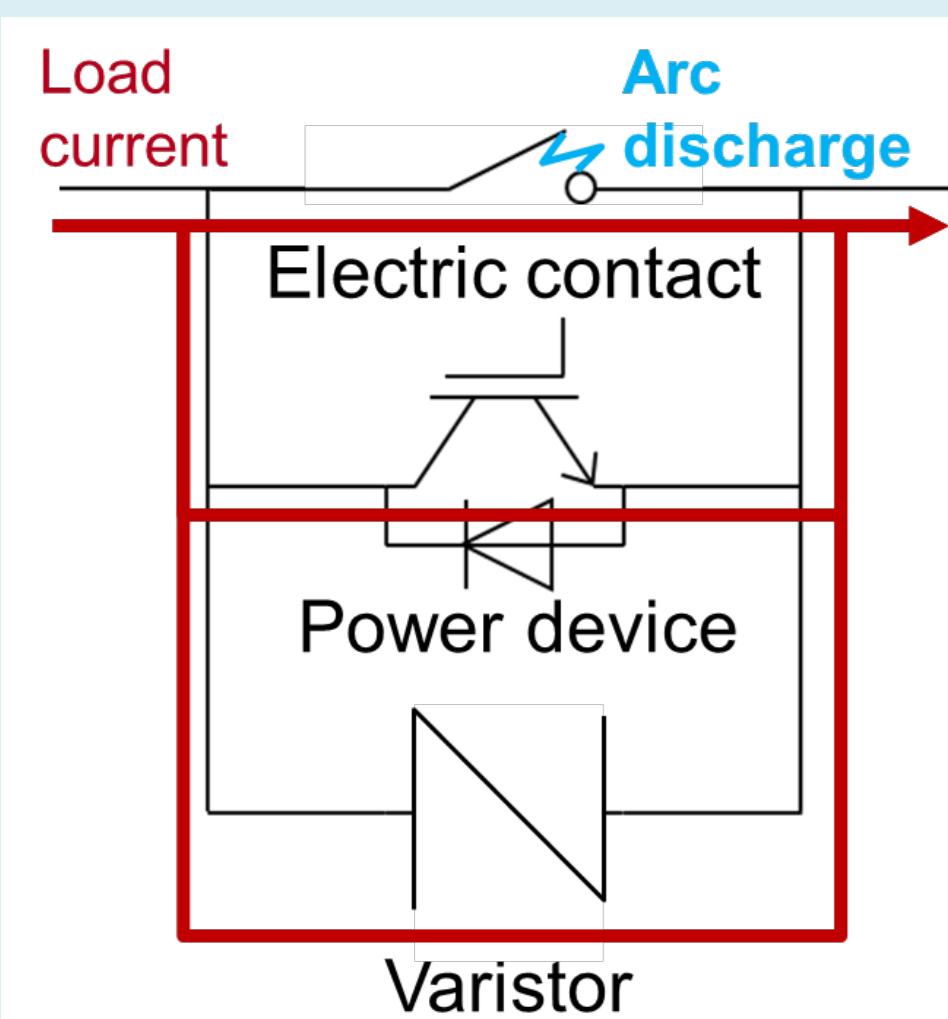
The demand of DC circuit breaker



DC current interruption is difficult.

Hybrid DC circuit breaker

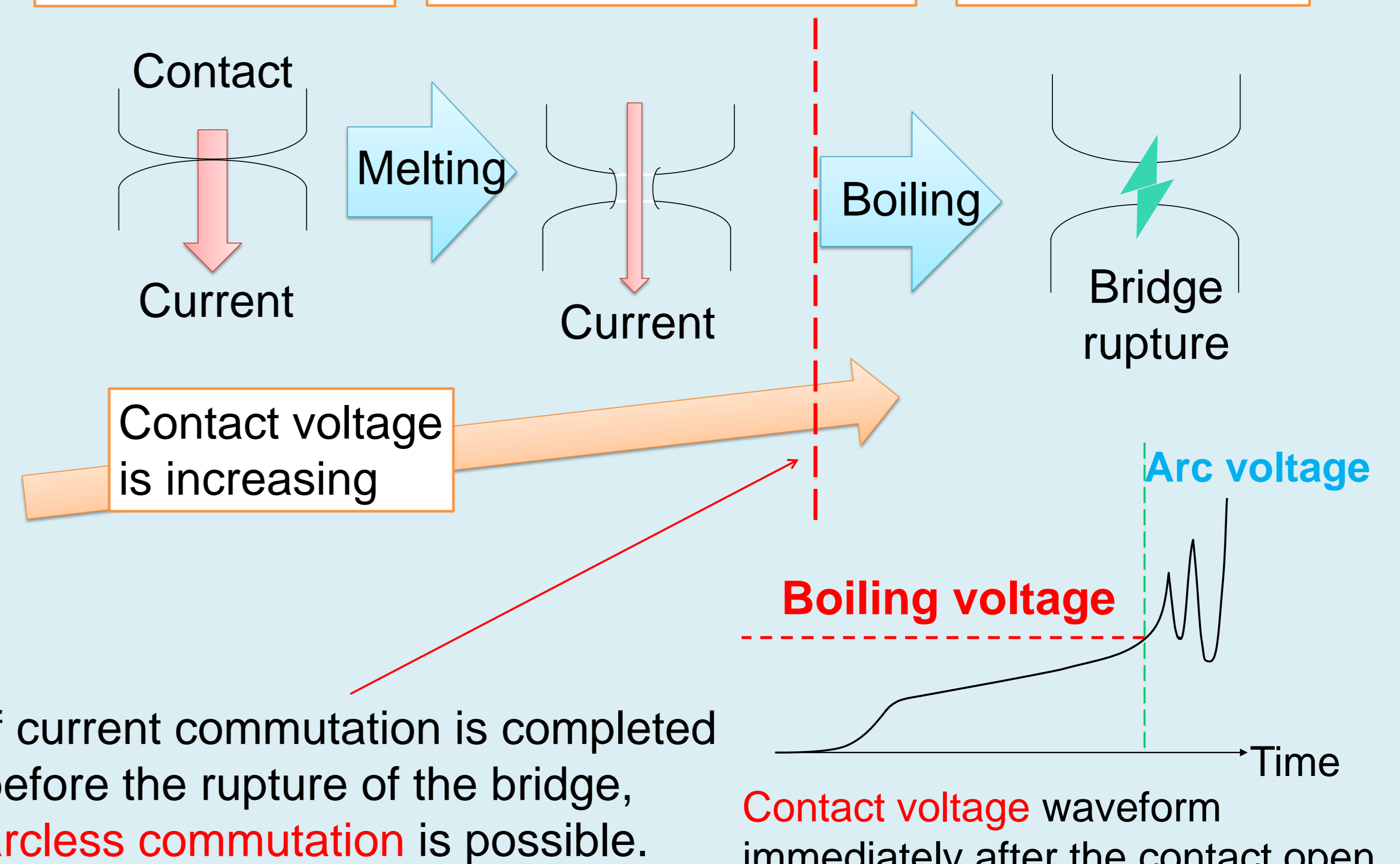
Low steady power loss and short arc duration



1. Load current flows through the electric contact
Reduction in steady power loss
2. The contact open → Arc discharge → Arc voltage transfers the current to power device
Current commutation
3. Inductive energy of circuit is absorbed by varistor when the device is turned off
Reduction in arc duration and contact erosion

Principle of arcless DCCB

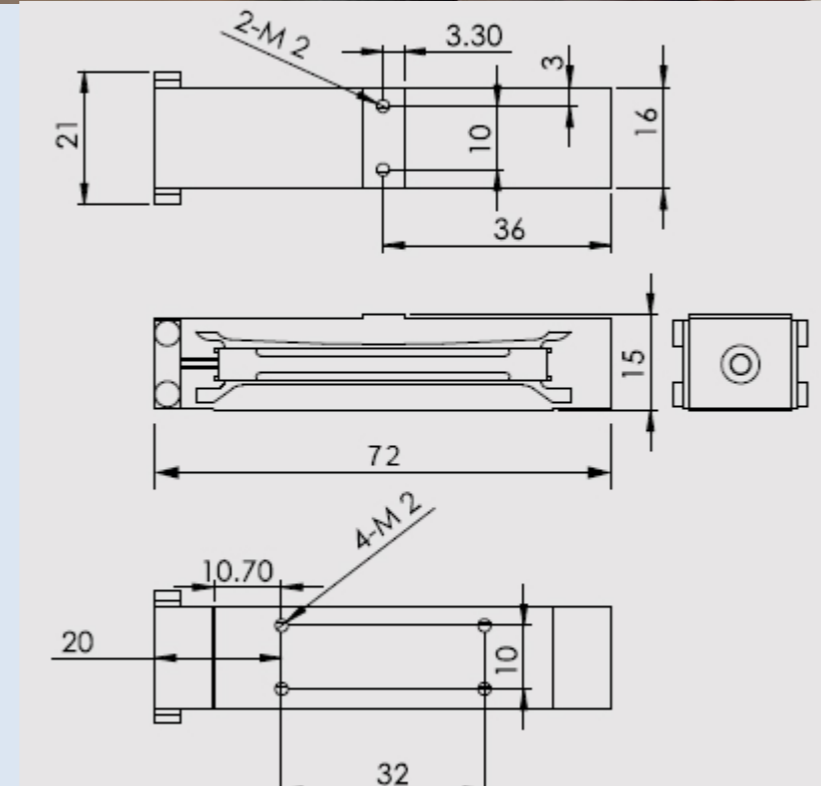
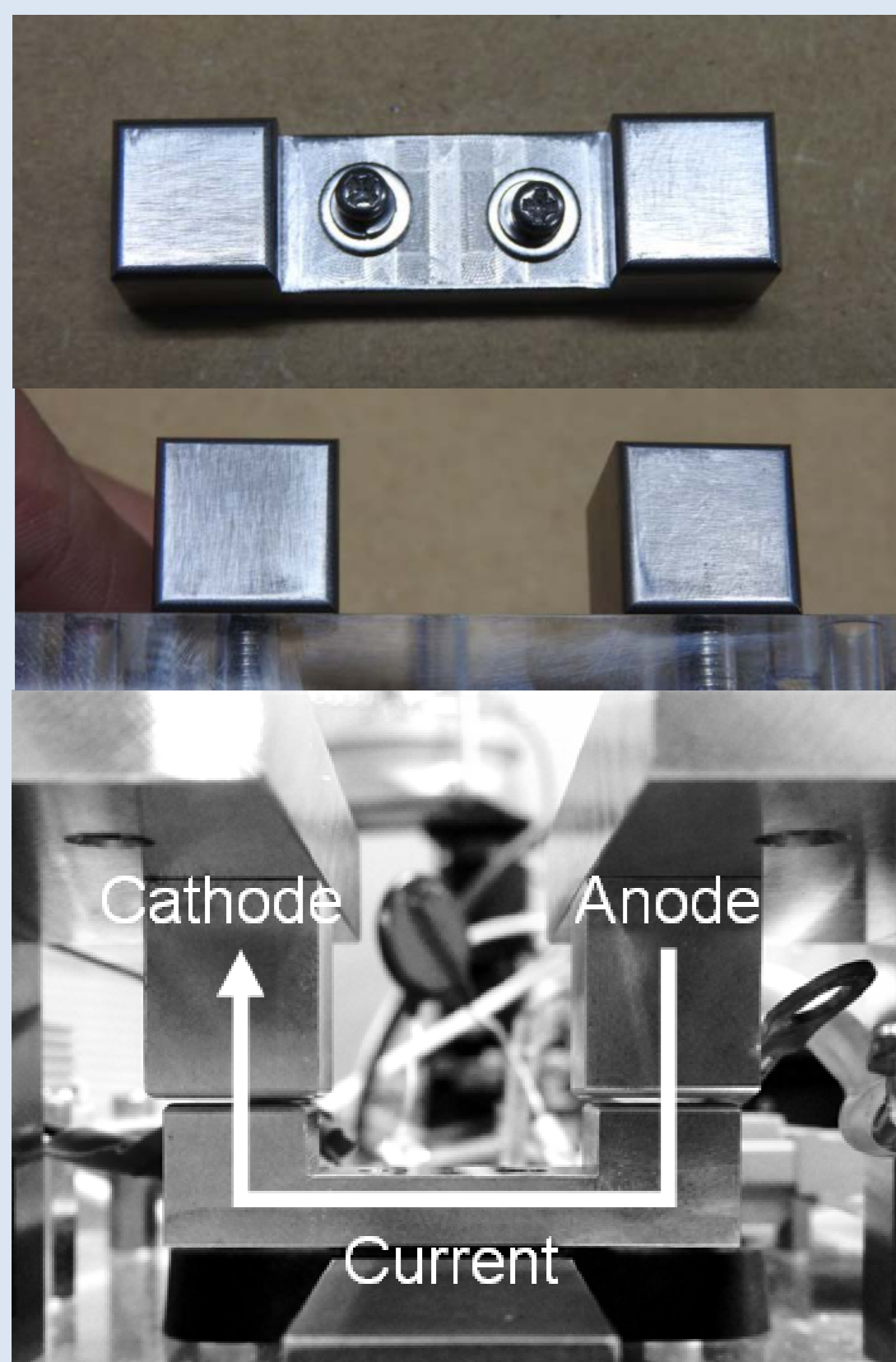
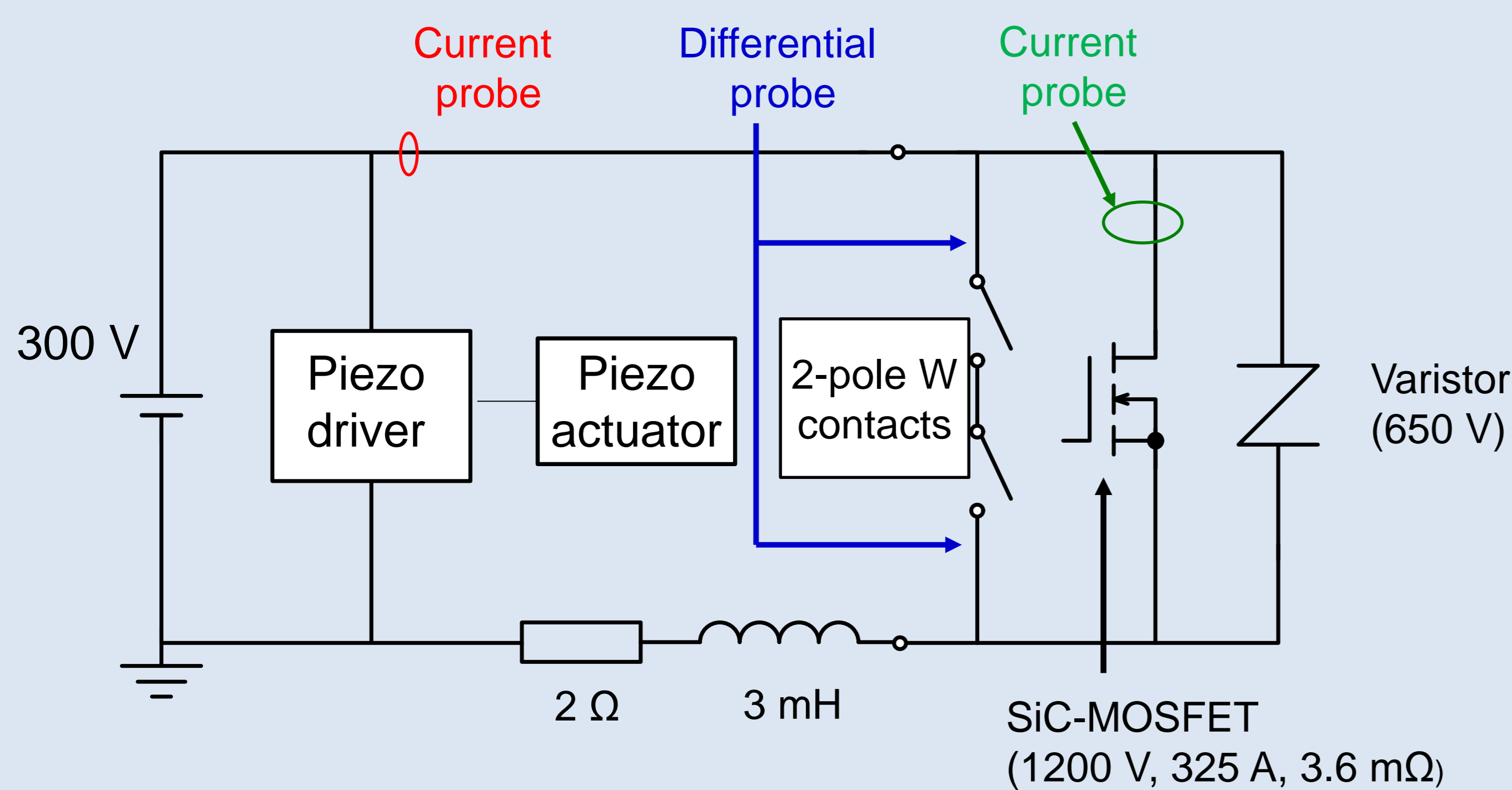
Reduction of contact area Formation of Molten metal bridge Generation of arc discharge



If current commutation is completed before the rupture of the bridge, **arcless commutation** is possible.

Our object is development of an **arcless hybrid DCCB**

Experimental setup



Piezo actuator

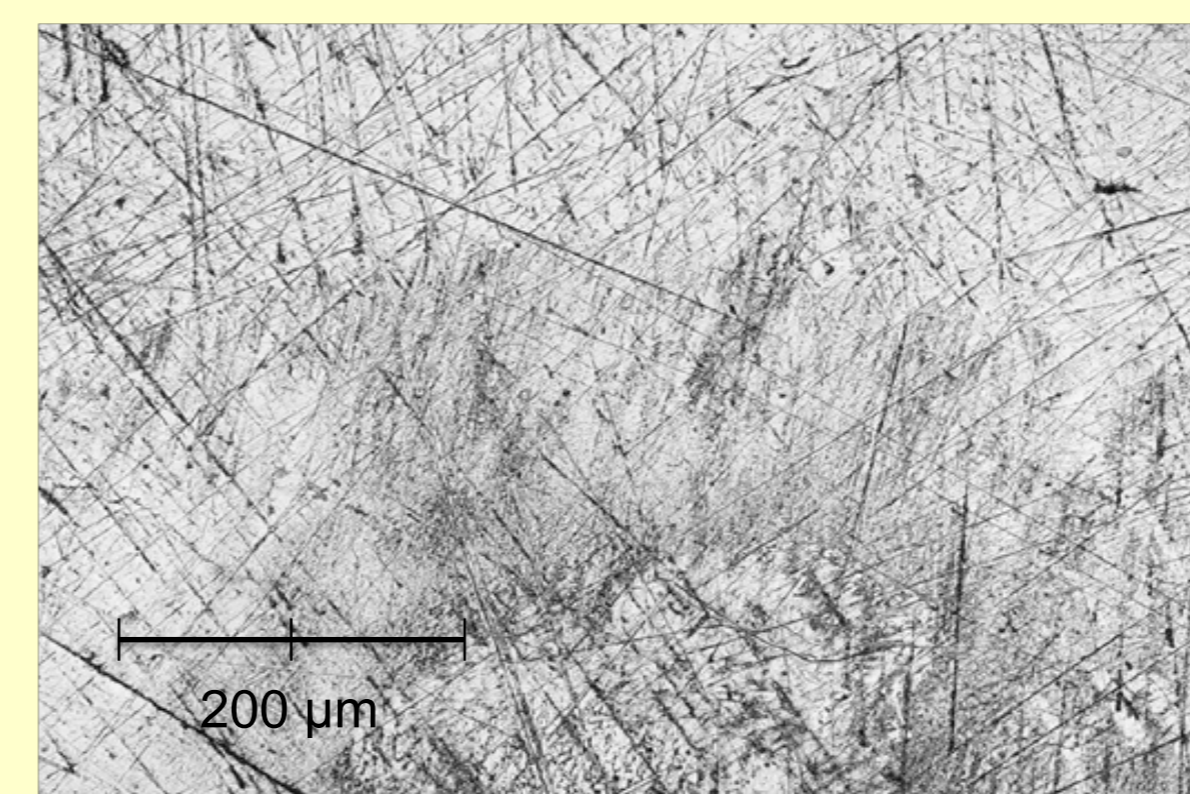
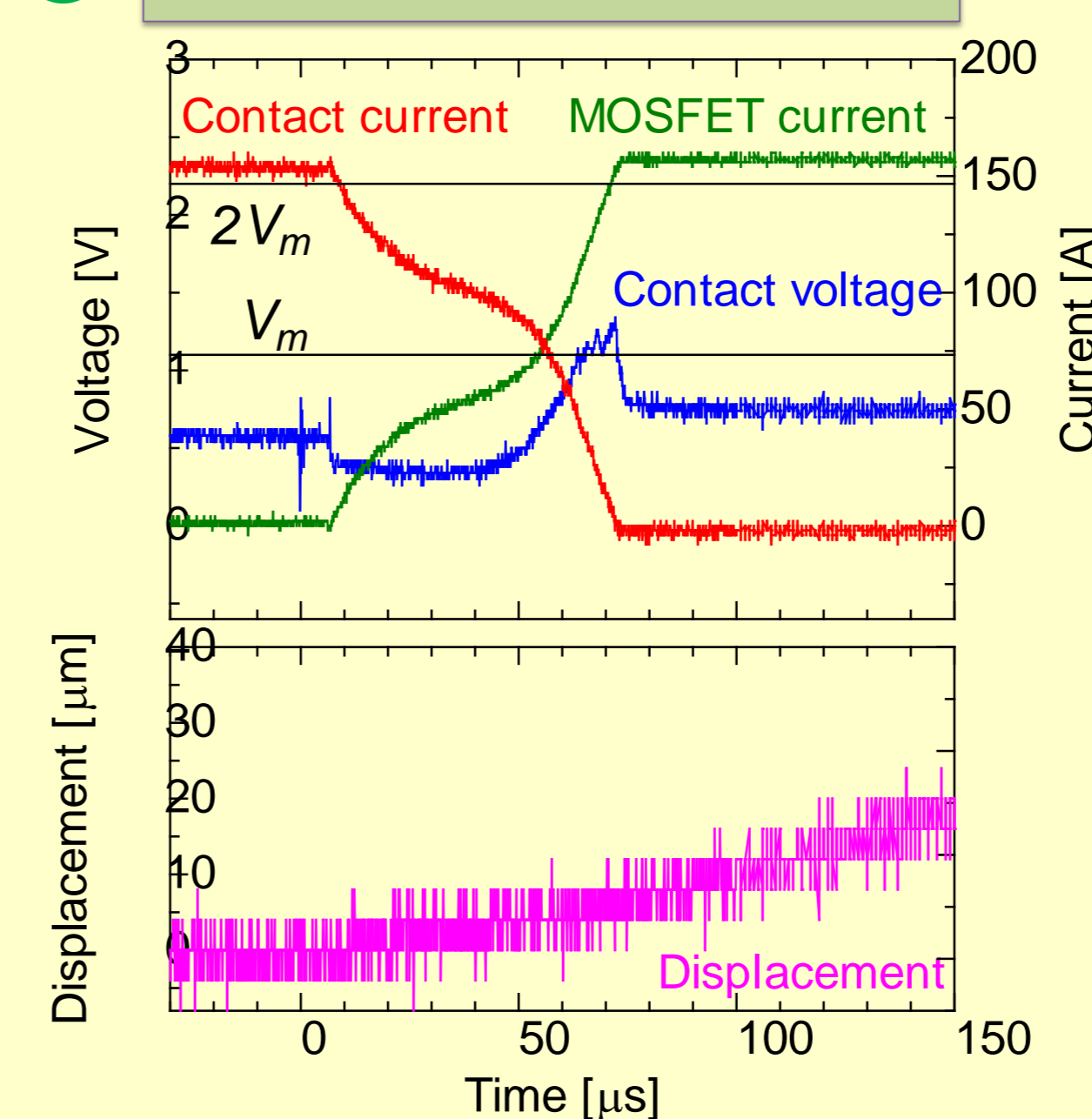
- Peak displacement 400 μm
- Capacitance 12.5 μF
- Generative force 170N
- Open time 1.5 ms

2-pole W contacts

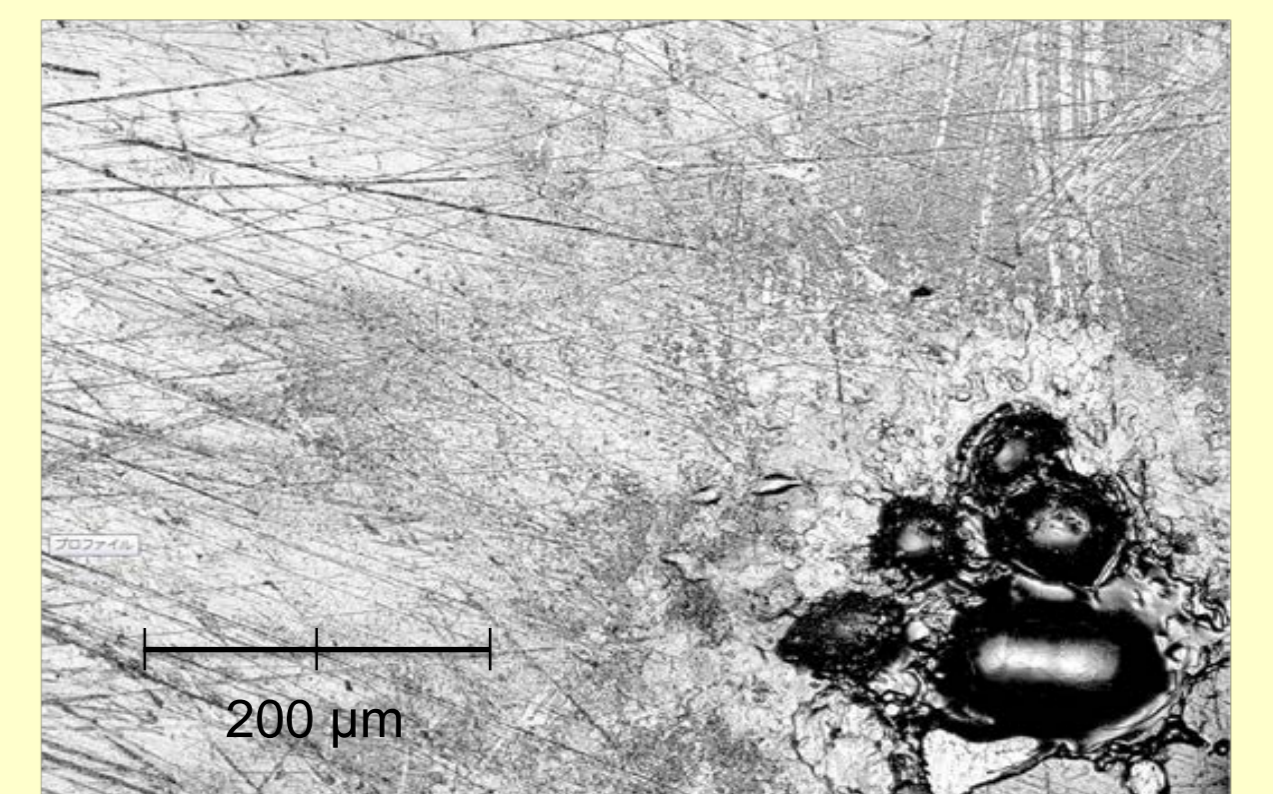
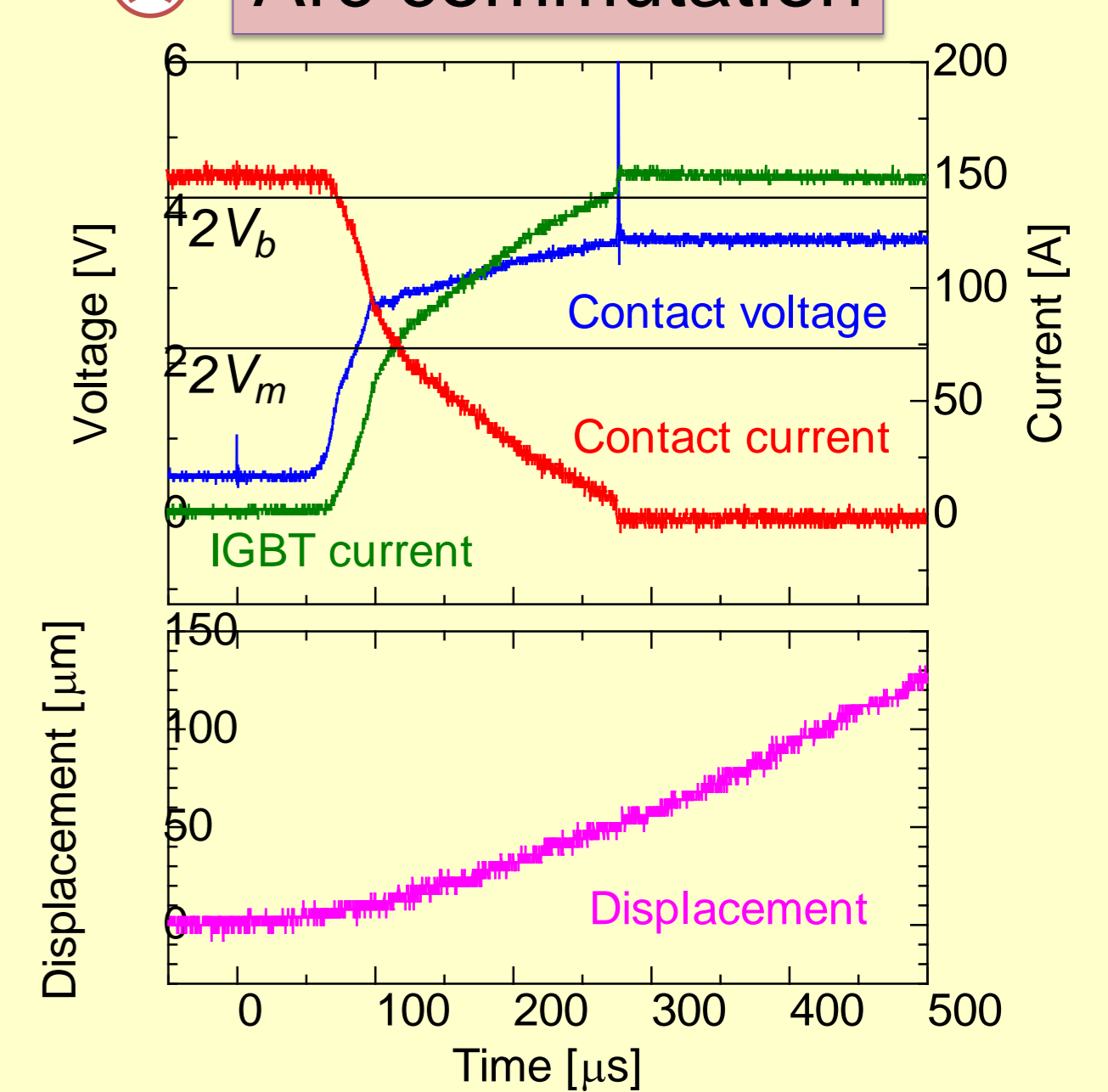
- Boiling voltage $2V_b=4.2\text{V}$

Results and Discussions

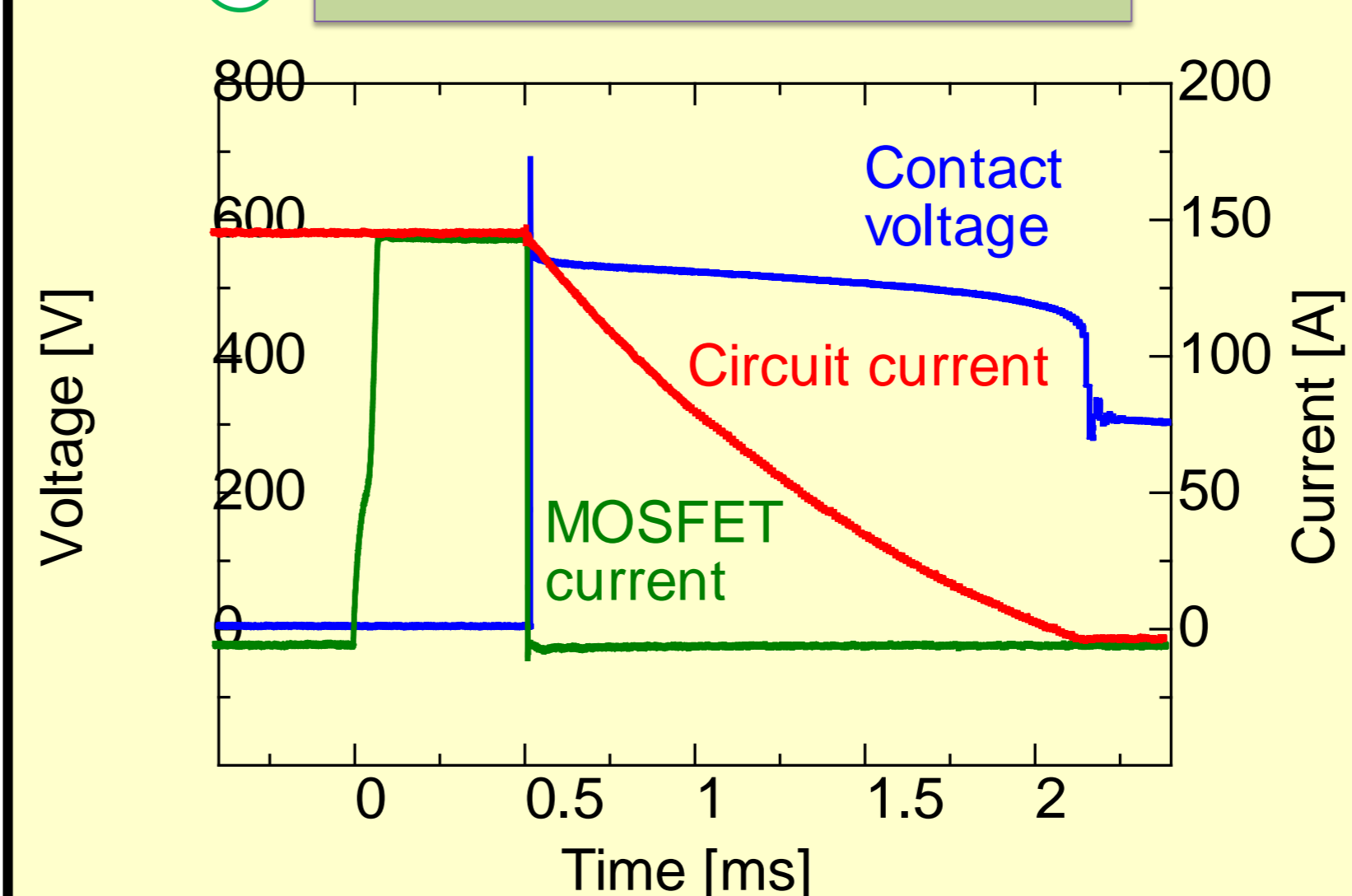
Arcless commutation



Arc commutation



Arcless circuit breaker



Arc circuit breaker

