Looking for Life in the Icy Crust of Europa

Chinmayee Govinda Raj[1], Nicholas Speller[1], Mike Cato[1], Zachary Duca[1], Junkyu Kim[2], Phil Putnam[3], Jason Epperson[3], Amanda M. Stockton[1]
[1]Georgia Institute of Technology, [2]Texas Tech University, [3]Sierra Lobo

Background

- Extraterrestrial icy worlds Europa and Enceladus are high priority targets for future missions given their potential to harbor life.
- Telescopic and flyby spacecraft data suggest presence of **saline global subsurface ocean**, tidal forces, plumes (transient on Europa, persistent on Enceladus) containing water, methane, carbon dioxide, ammonia, and **simple organics**. [1] Fig. 1.
- Characterizing these organics and salts in the ice-sheet samples informs about habitability and prospects for life. [2]

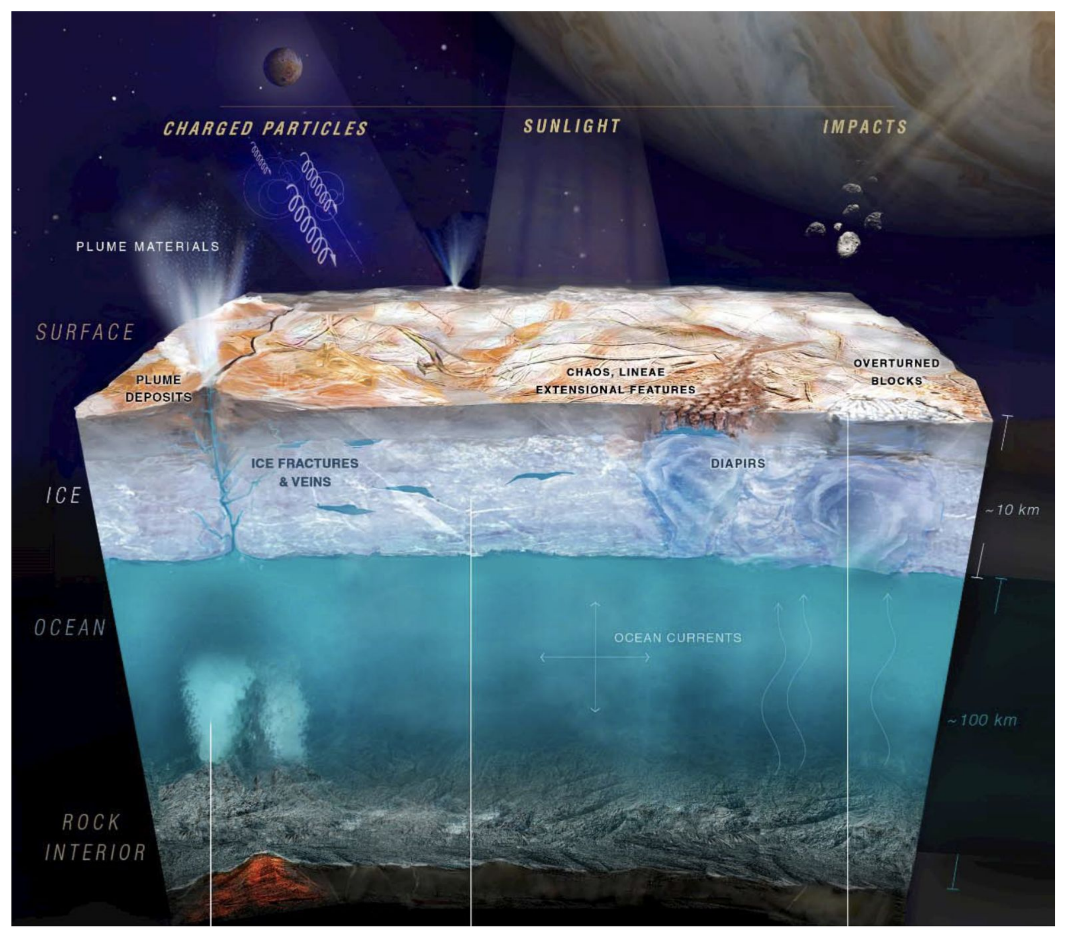

Figure 1: Europan surface, subsurface geology and radiation exposure. Image credit: NASA JPL

IMPOA Sample Collection Strategy

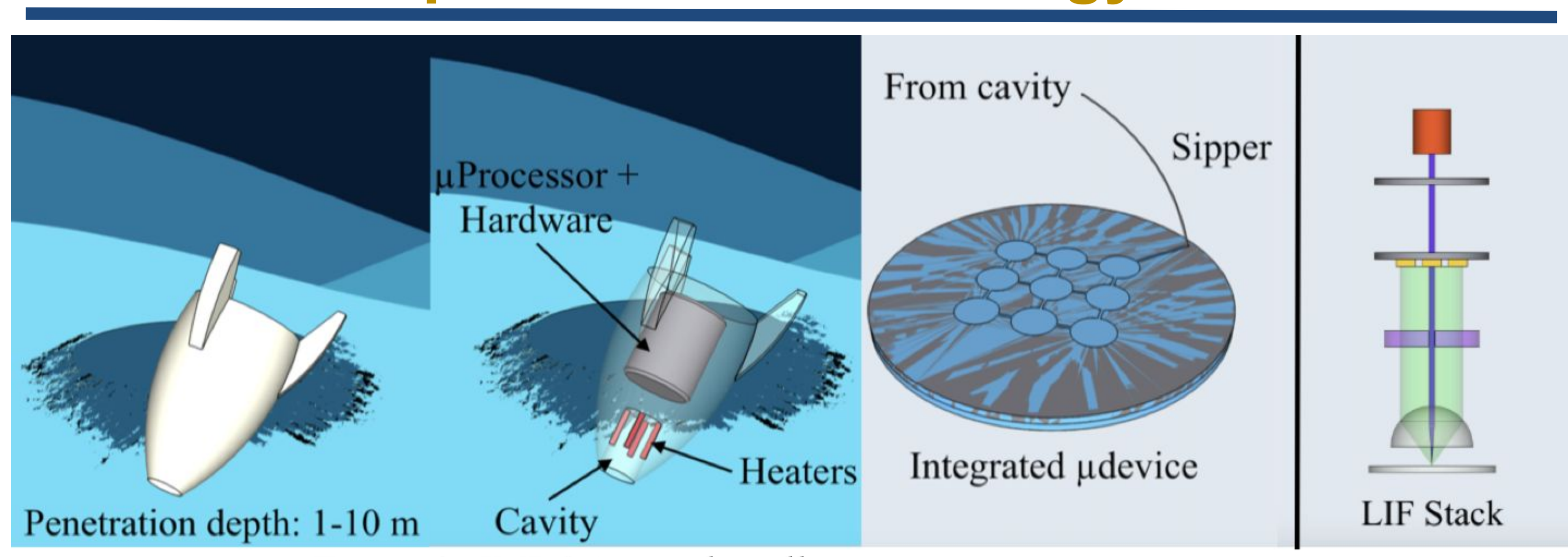

Figure 2: IMPOA sample collection strategy post-impact.

- **Icy Moon Penetrator Organic Analyzer (IMPOA).**
- *In-situ* sampler + analyzer.
- **No soft landing requirement.**
- **Survives 50,000 g impact force.**
- 10 m depth ice shelf penetration upon impact. (SDT reqmt. 10 cm) [3]
- Access to radiation shielded ice-crust samples.
- Single axis optical system - laser induced fluorescence (LIF).
- Hydraulic pumping and valve microfluidic system.

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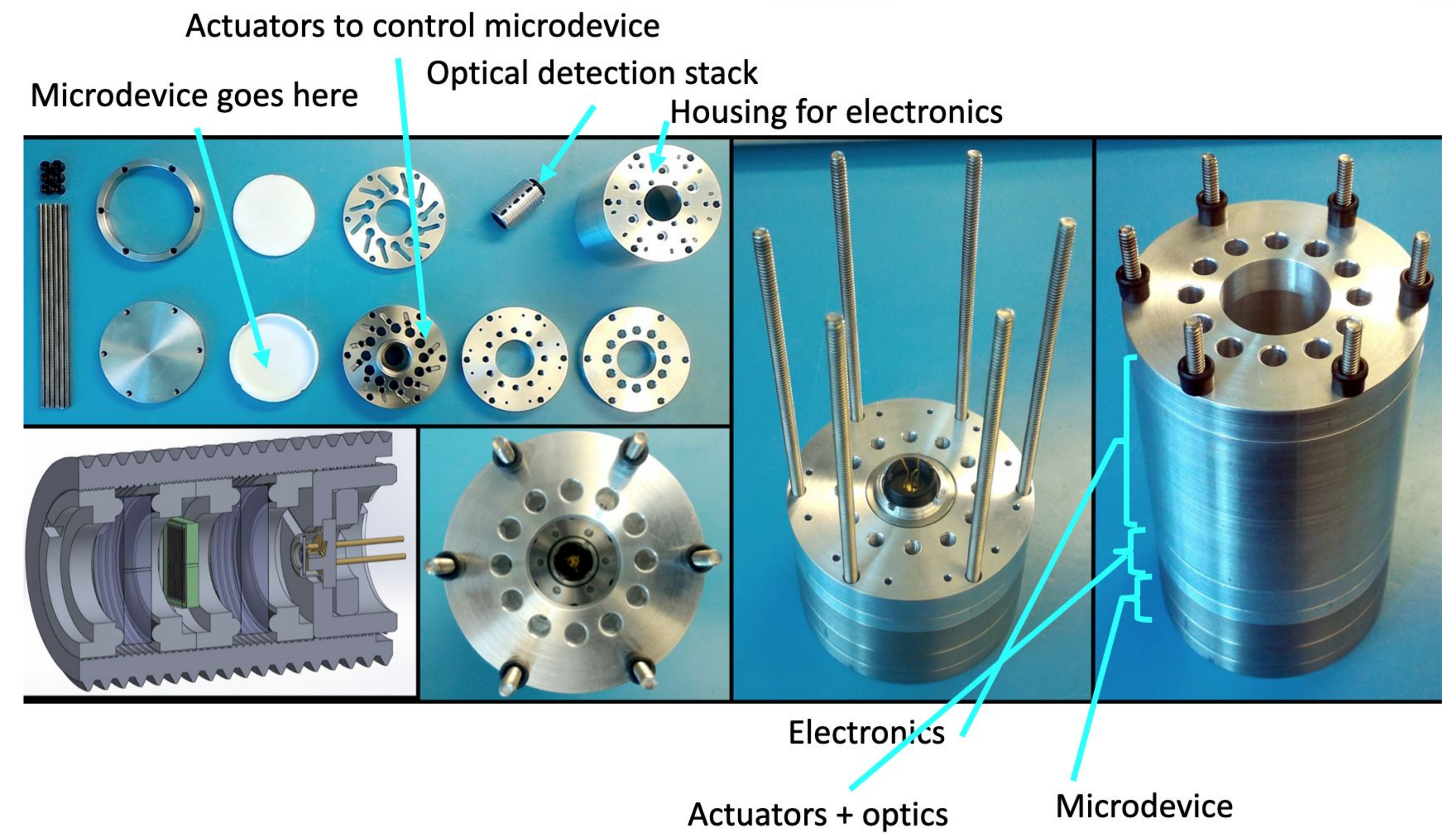


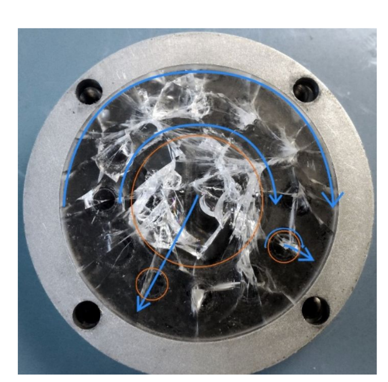
Figure 3: IMPOA stack sub-components.

IMPOA Impact Tests and Results

Figure 4: Facility at Sierra Lobo for impact tests. (a) M100 and airgun assembly used to accelerate and impact the impactor capsule. (b) Test article body/impactor capsule.

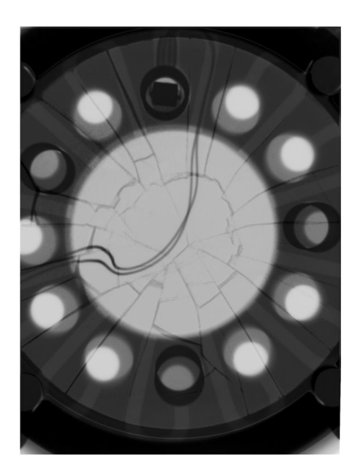
Test 1: 12,000 g acceleration

Microcontroller potted in polyurethane and piezoelectric actuators survived fully. Microdevice fracture -> requirement of stiffer gasket



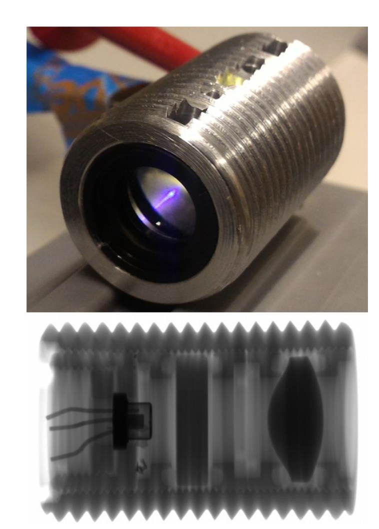
Test 2: 24,000 g acceleration

Piezoelectric actuators and mock optics survived fully but dislodged and damaged the microdevice and needed stronger support material.



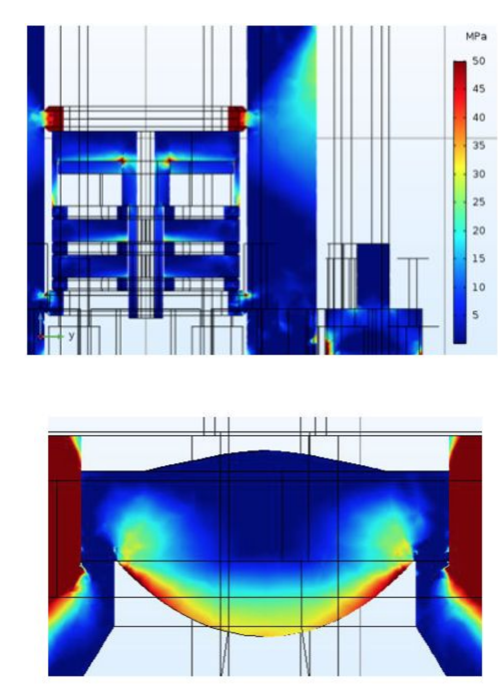
Test 3: 40,000 g acceleration

Piezoelectric actuators and mock optics survived fully. Microdevice fracture indicated the need for its own side supports.



Test 4: 50,000 g acceleration

Modeled. Indicated complete survival.



Contactless Sensor Fabrication Procedure

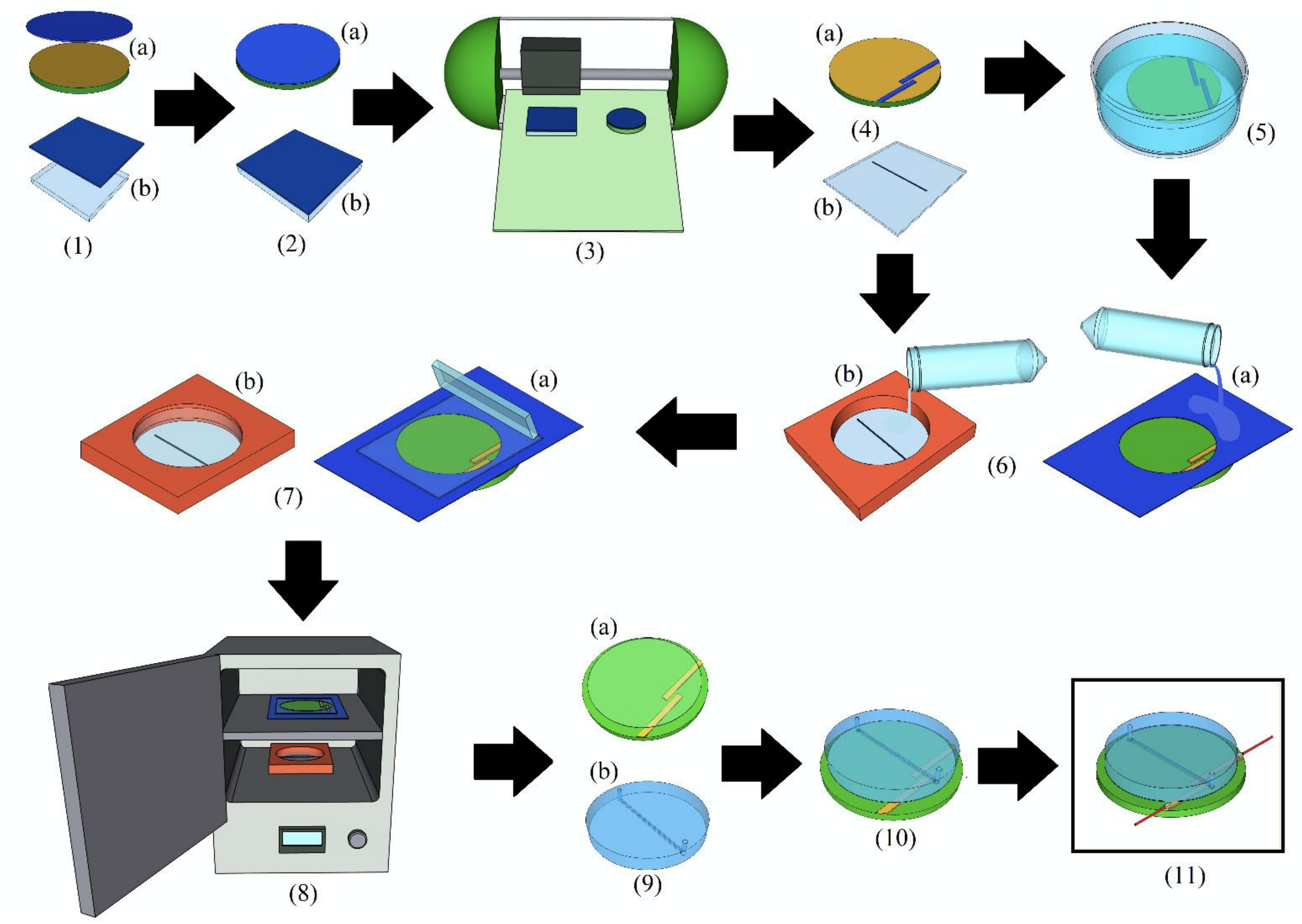
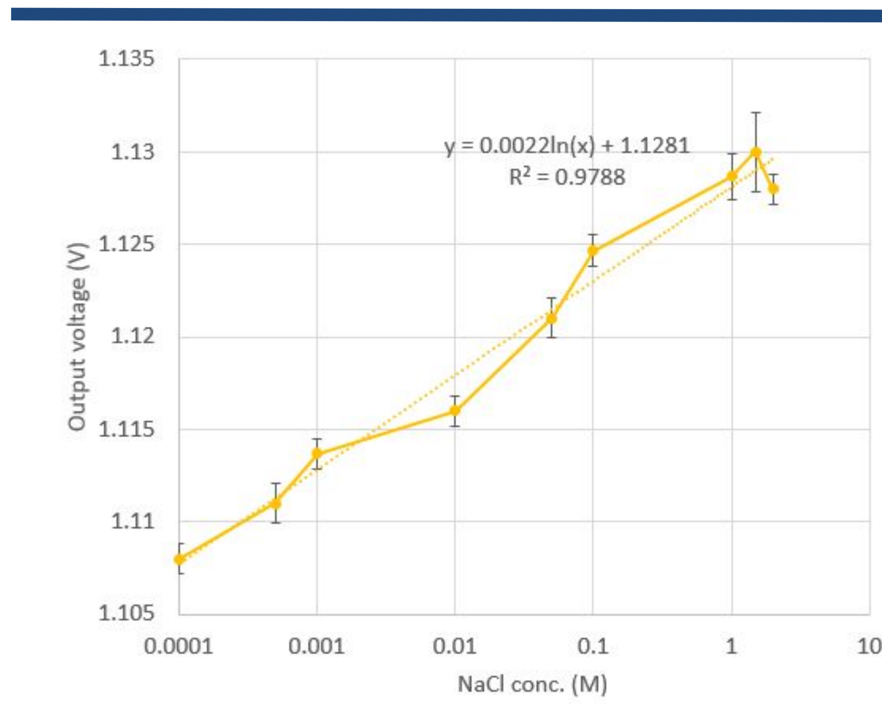


Figure 5: C^4D device fabrication procedure. [4]

Results and Future Work



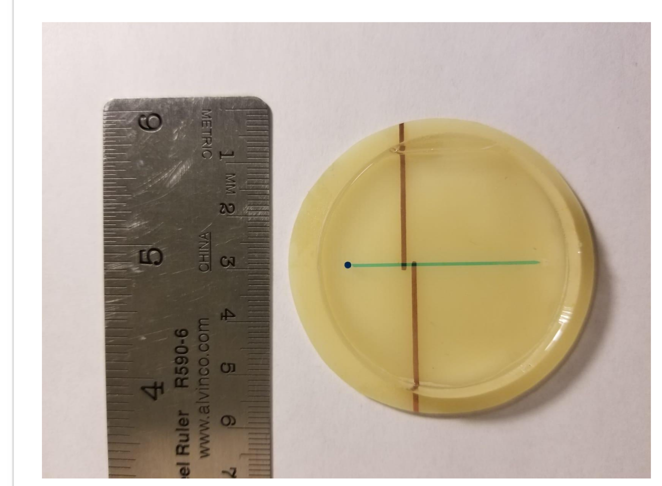


Figure 6: C^4D NaCl results and device. [5]

KCl, $MgSO_4$, Na_2SO_4 to be added in the future.

References

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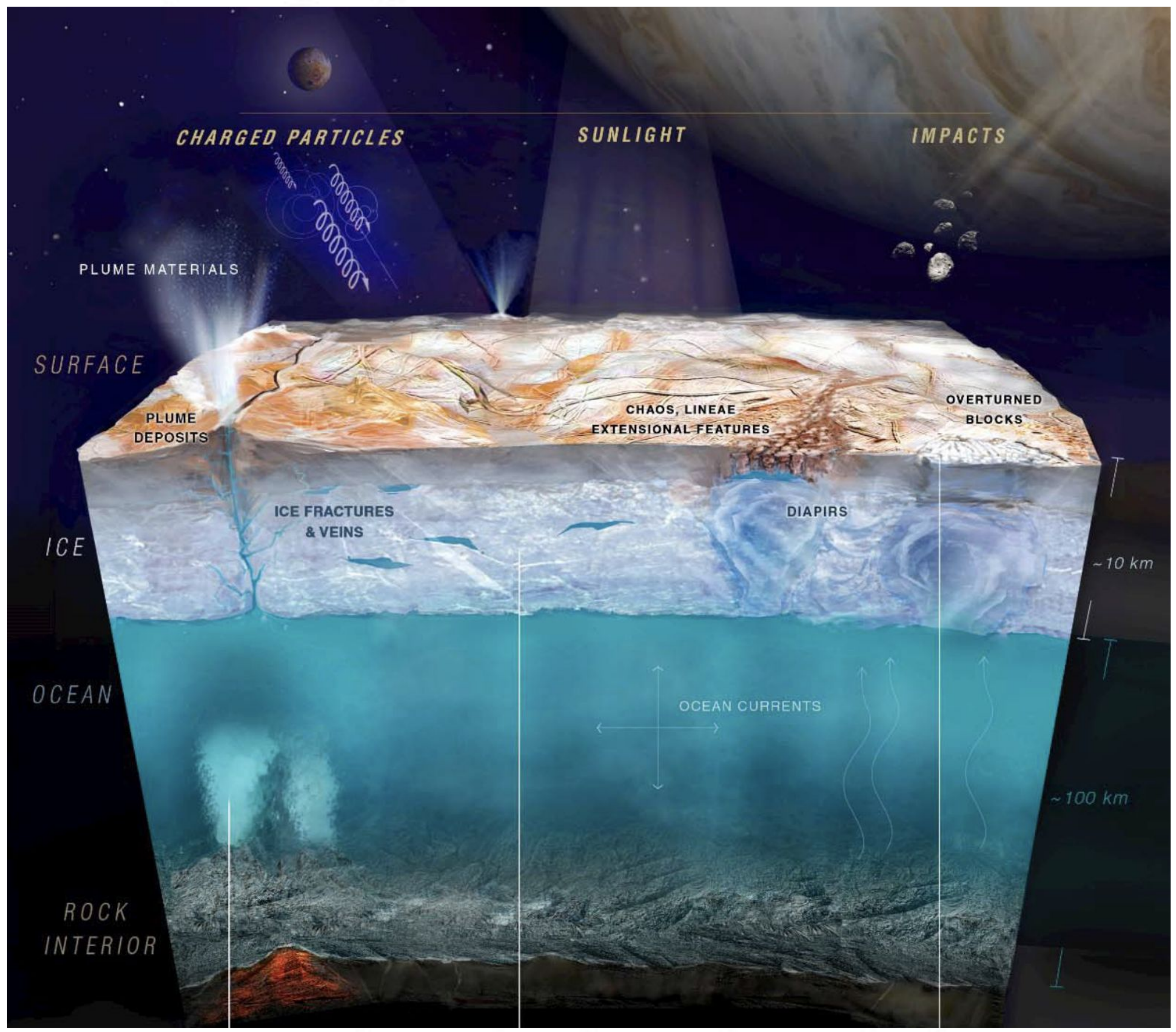

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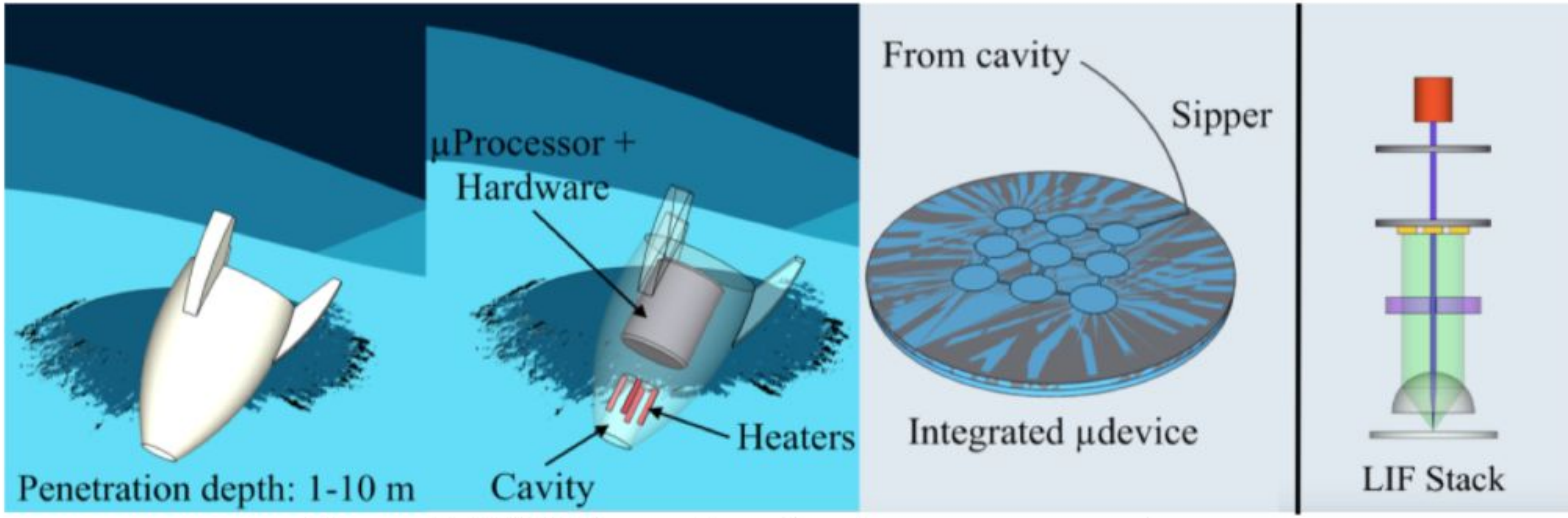

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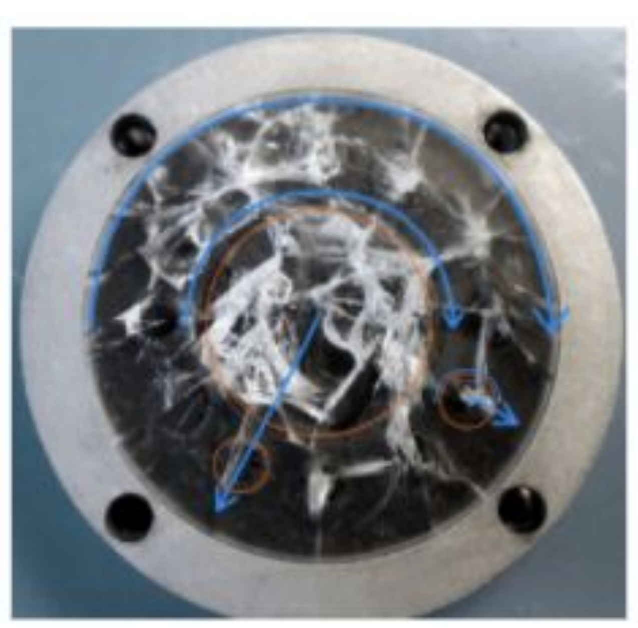

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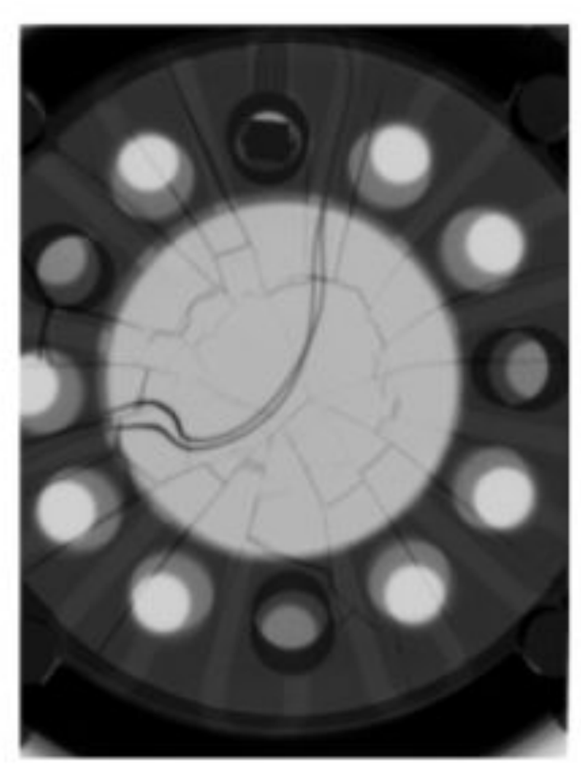

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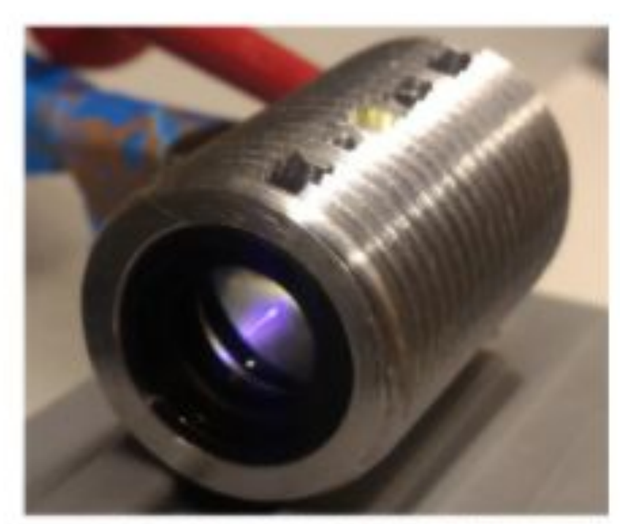

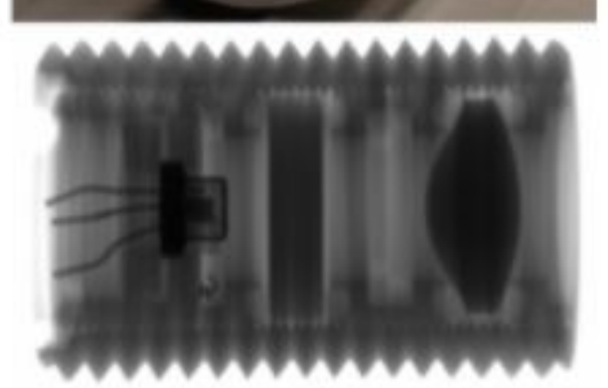

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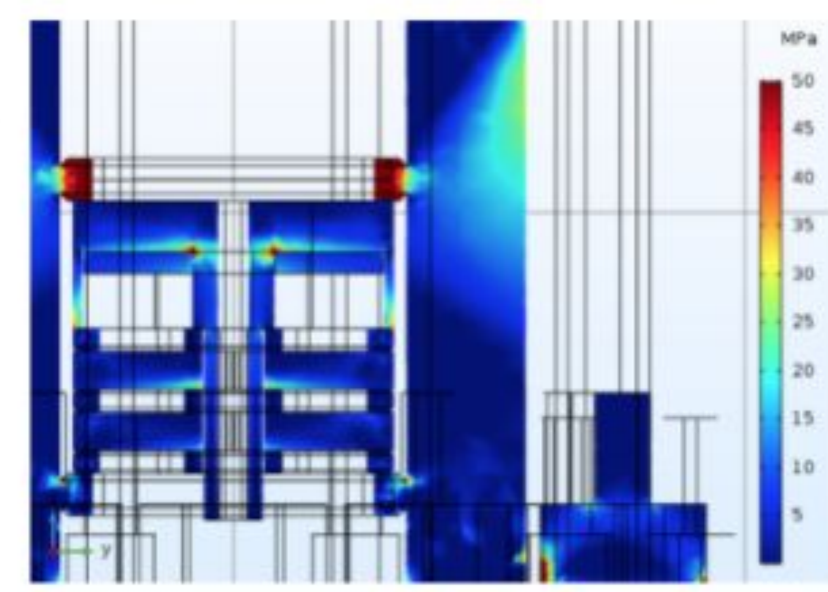

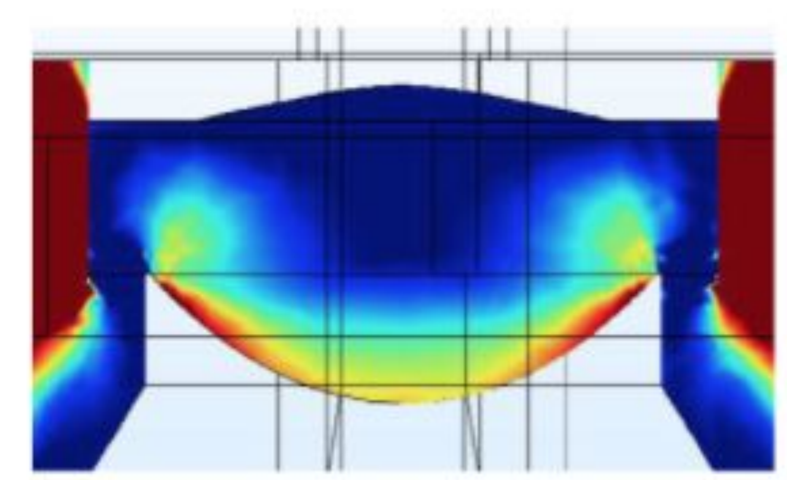

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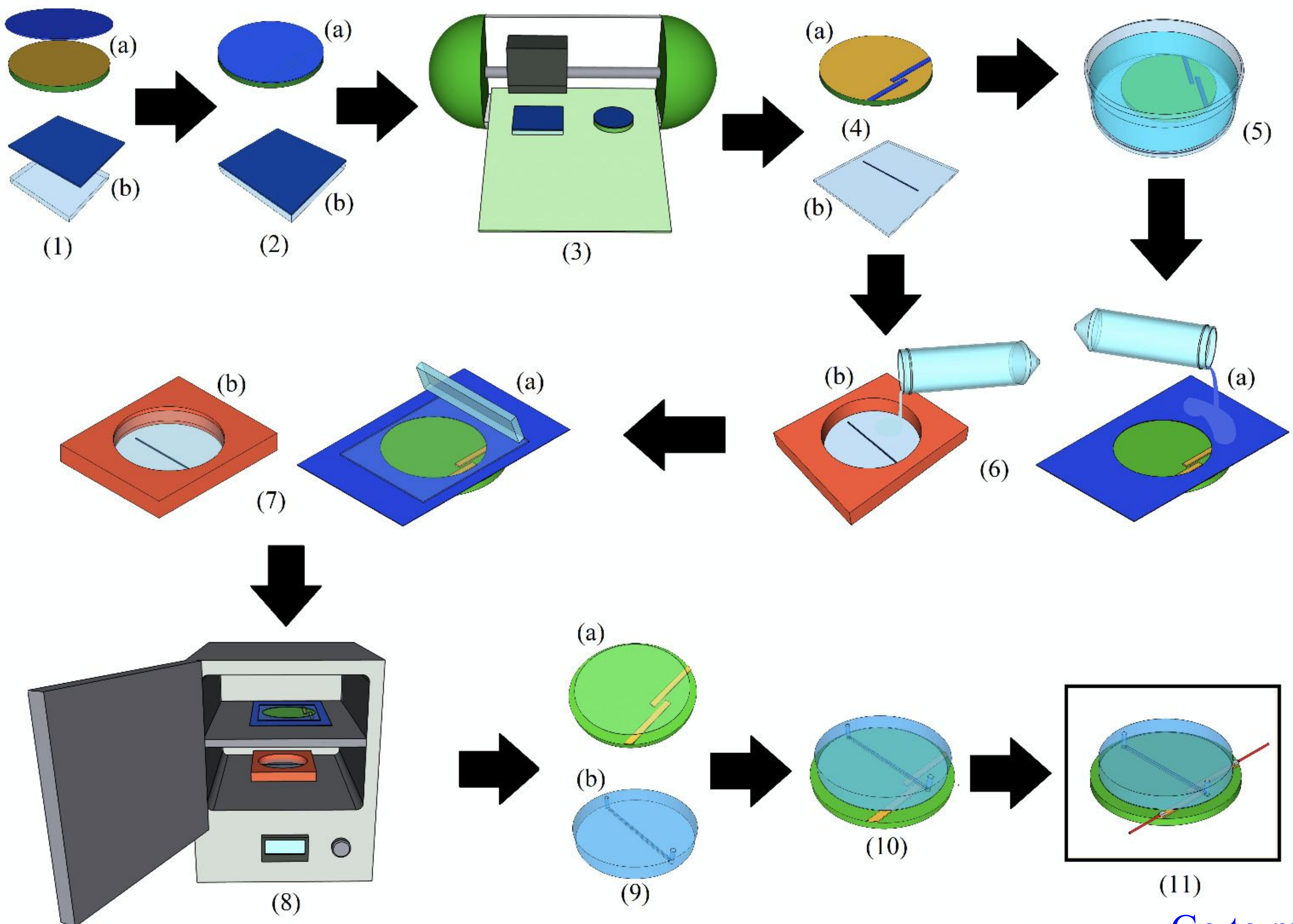

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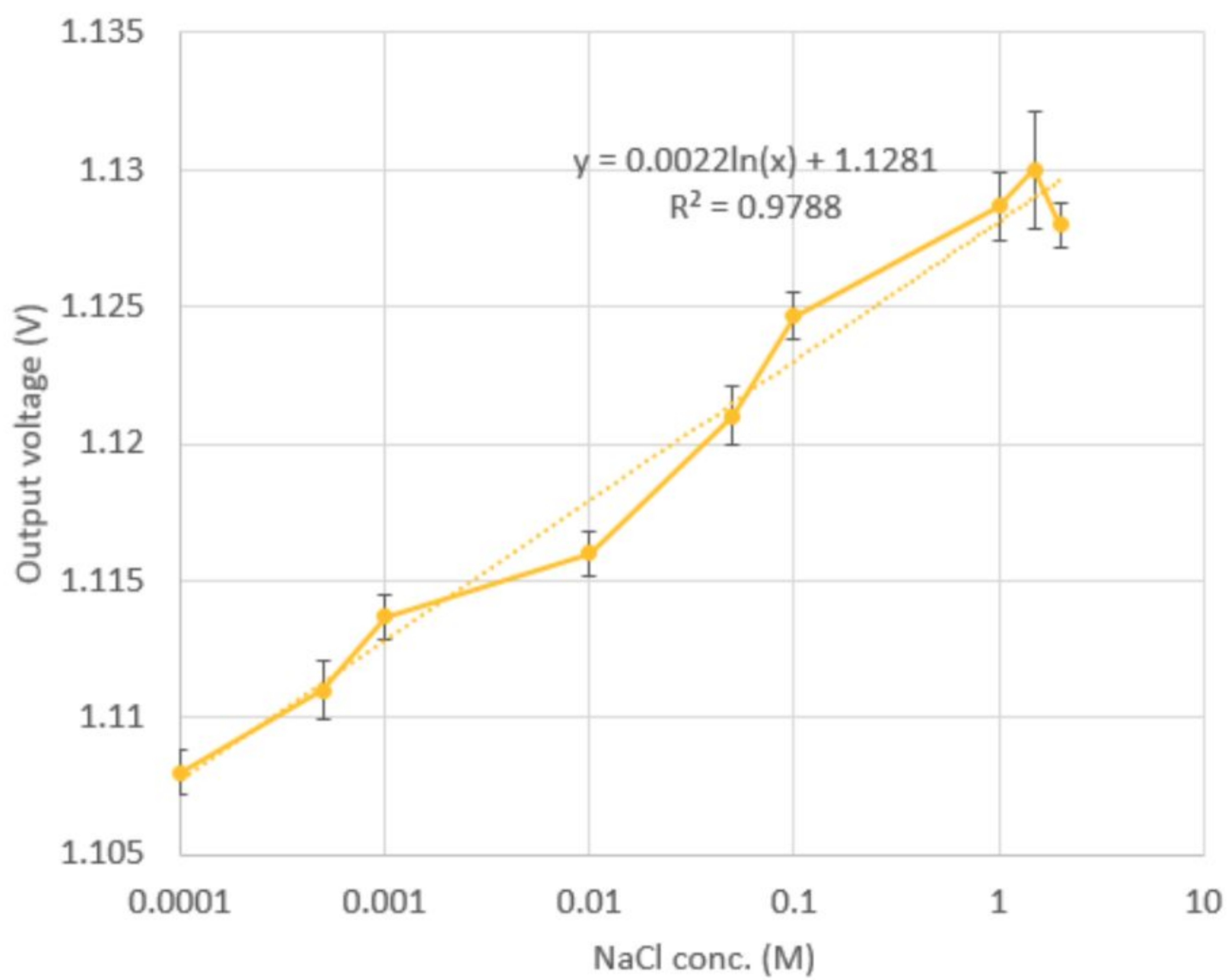

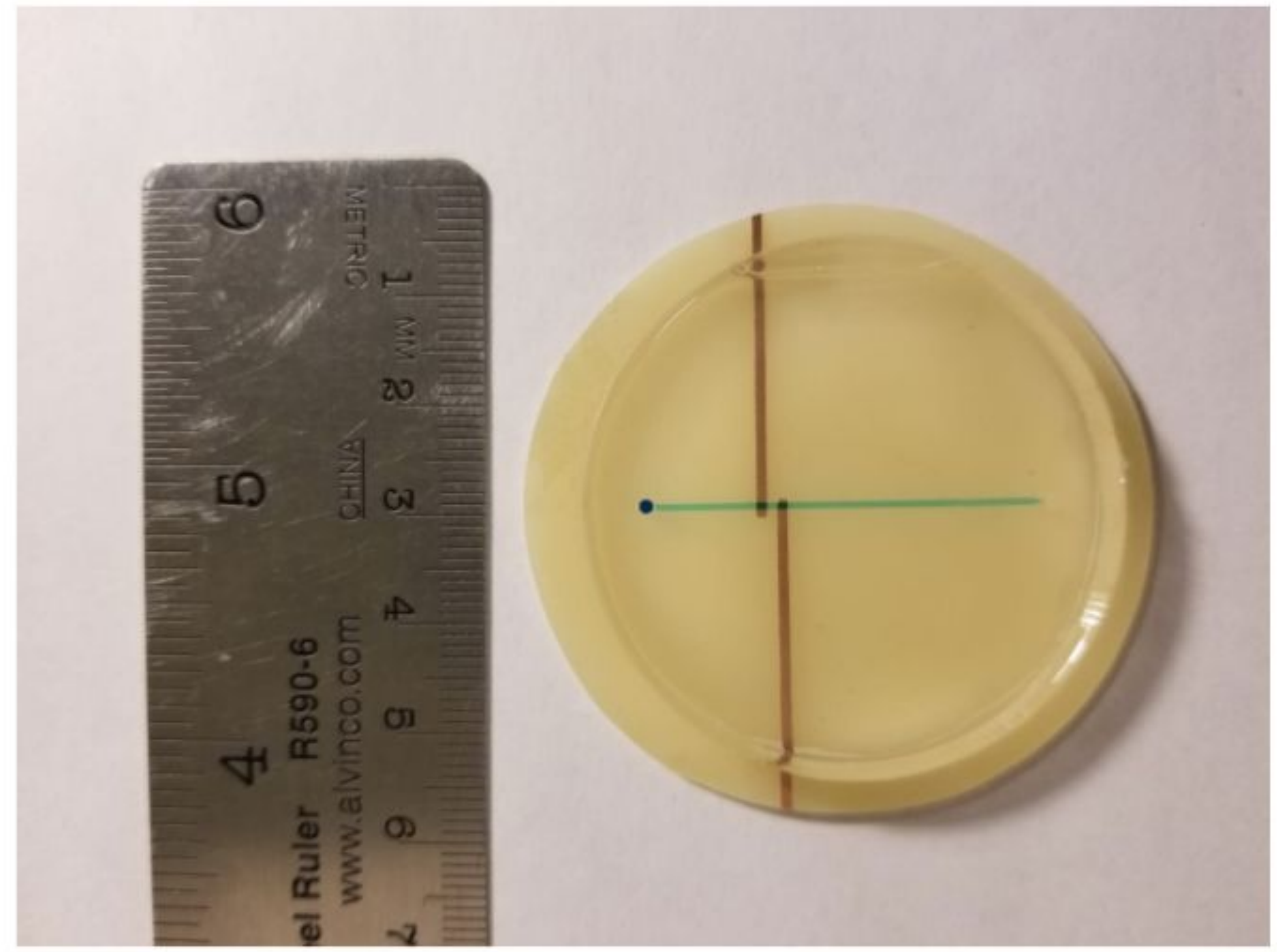

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