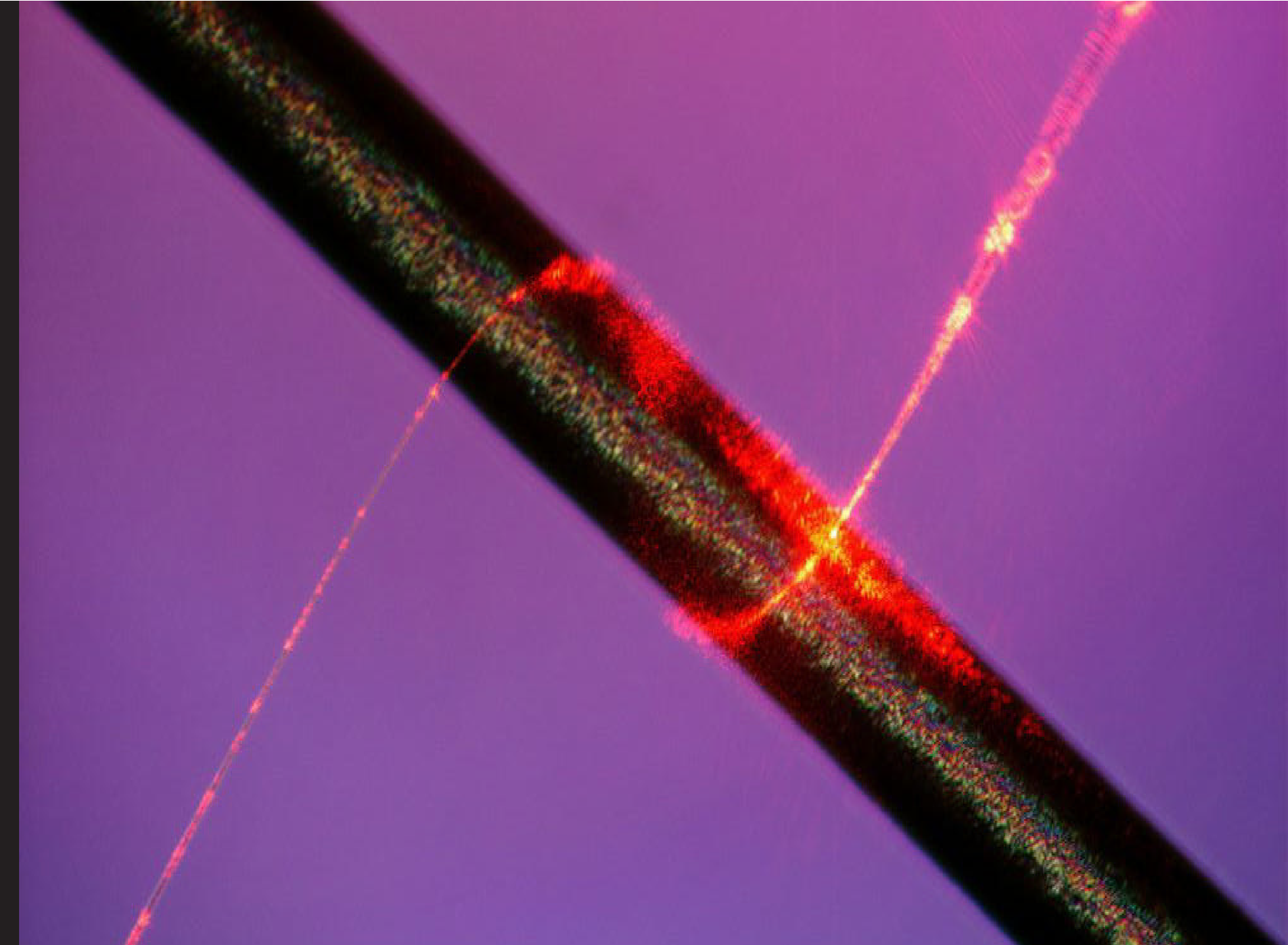
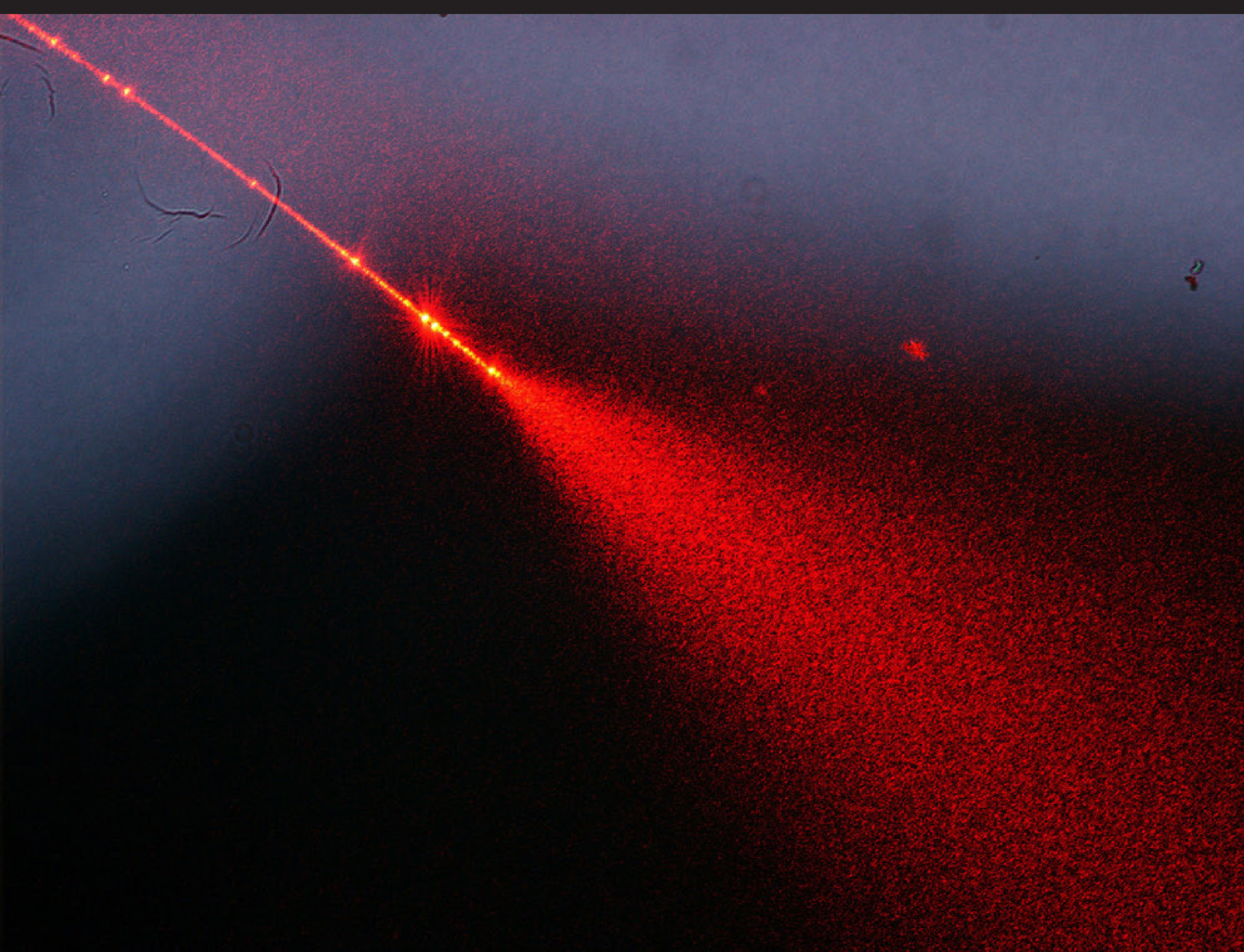
Wrapping light around a hair:

Using light at the nanoscale



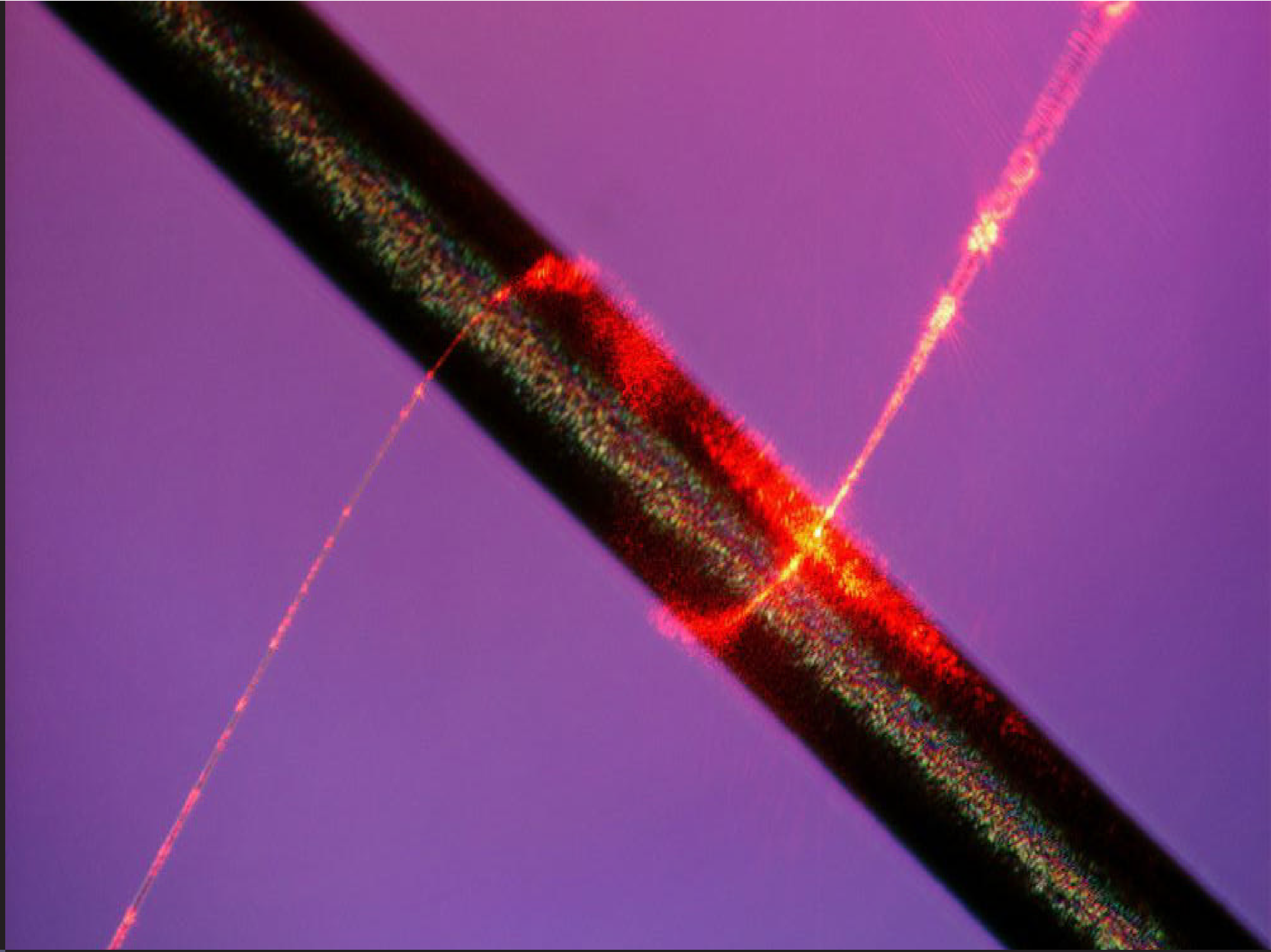


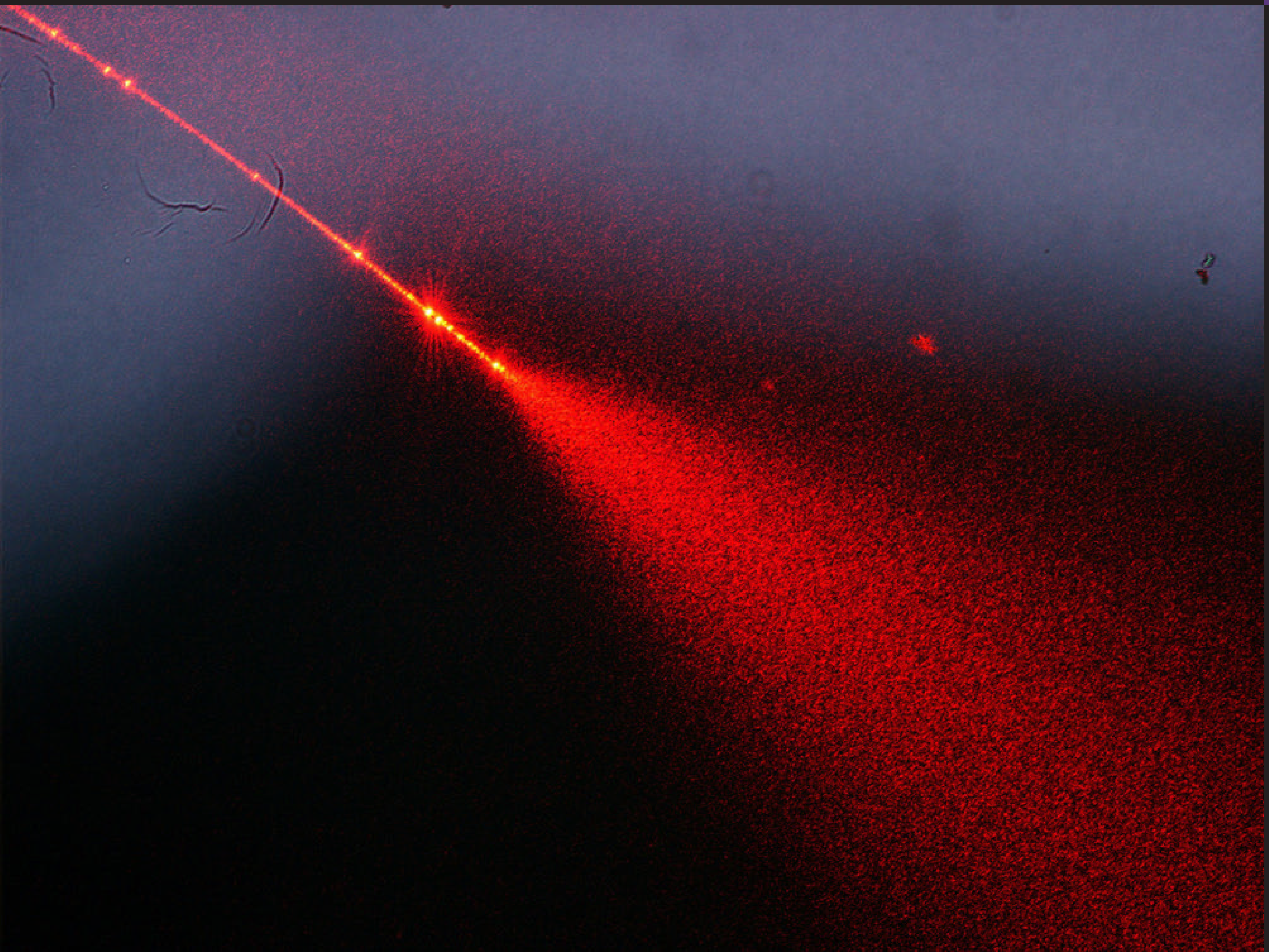
Eric Mazur
Harvard University

Museum of Science
Current Science & Technology
21 April 2007, 2:30 pm

This talk is about:

- guiding light
- nanotechnology





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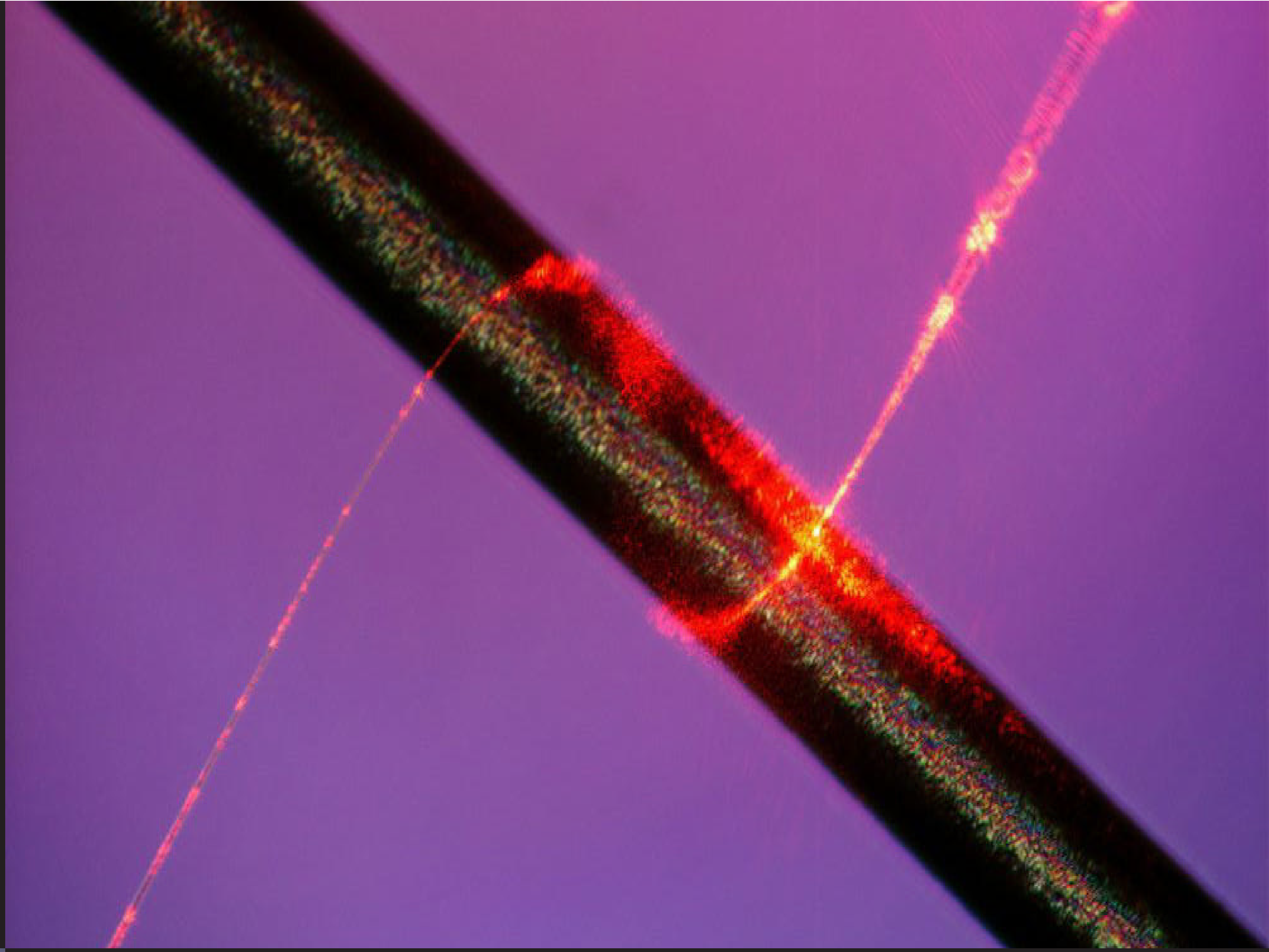
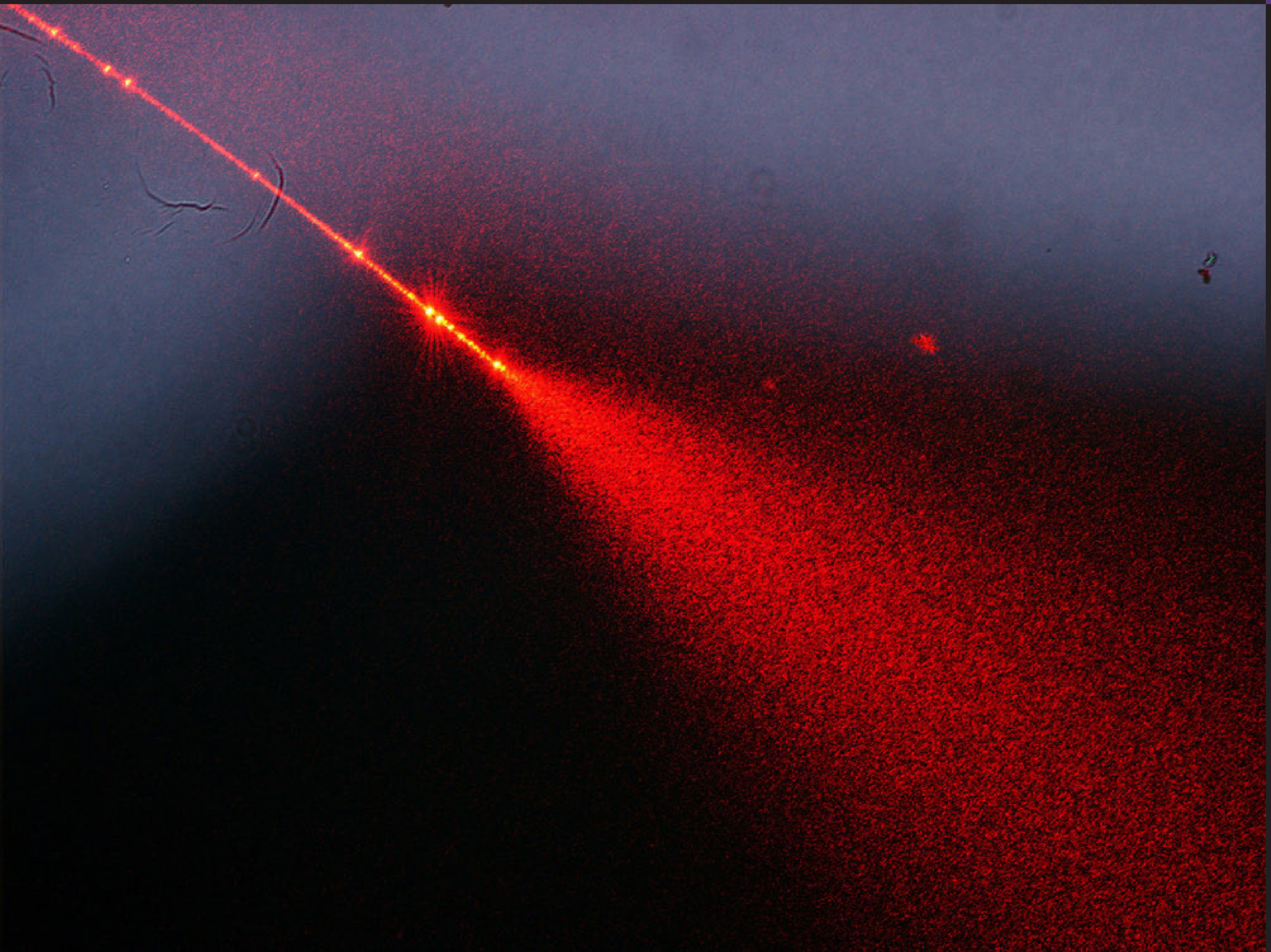
Current Science & Technology
21 April 2007, 2:30 pm

What is 'nanotechnology'?

The fabrication of devices of nanometer size





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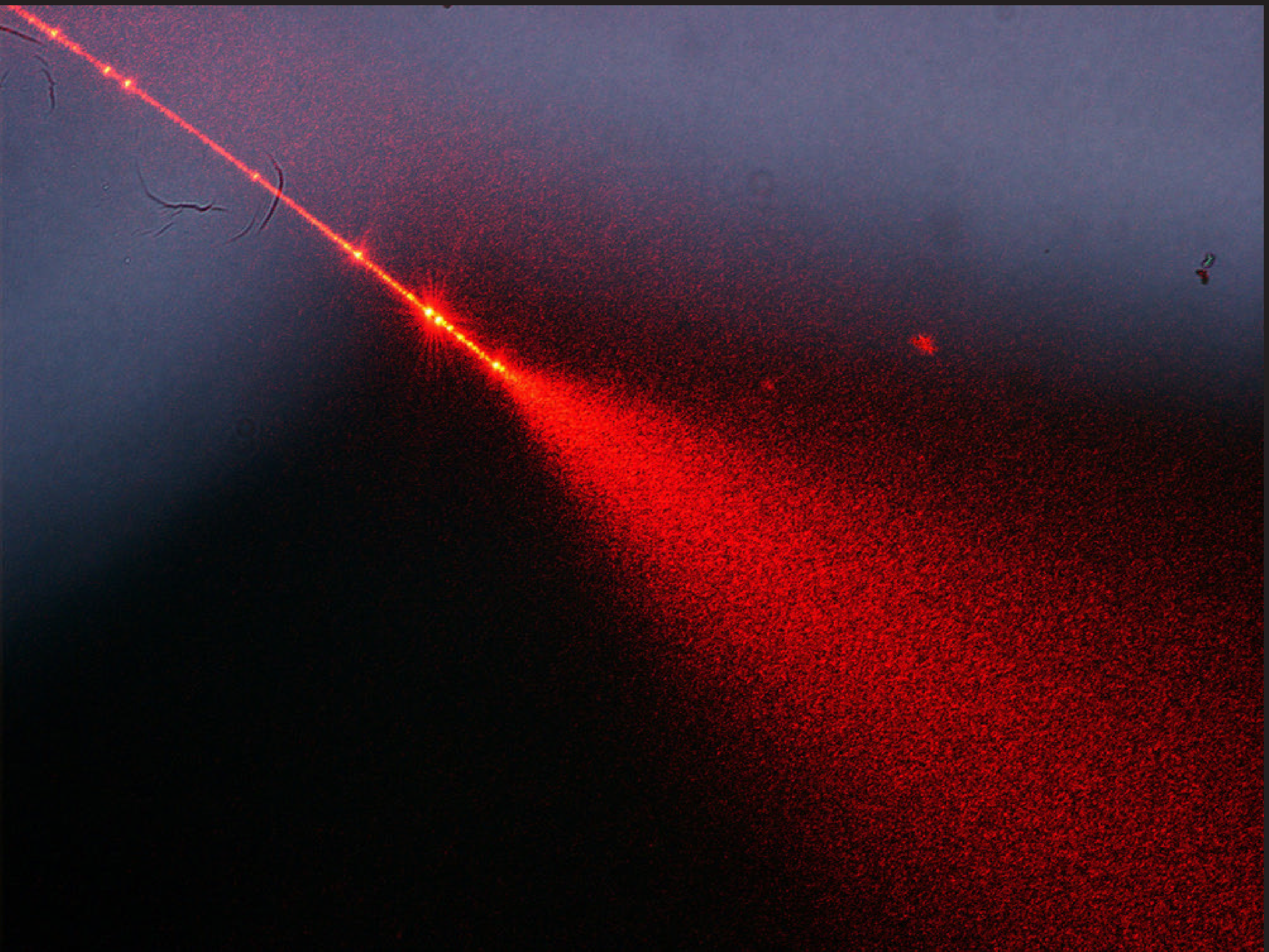
Current Science & Technology
21 April 2007, 2:30 pm

What is ‘nanotechnology’?

1 m = one meter

The fabrication of devices of nanometer size

one large step



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21 April 2007, 2:30 pm

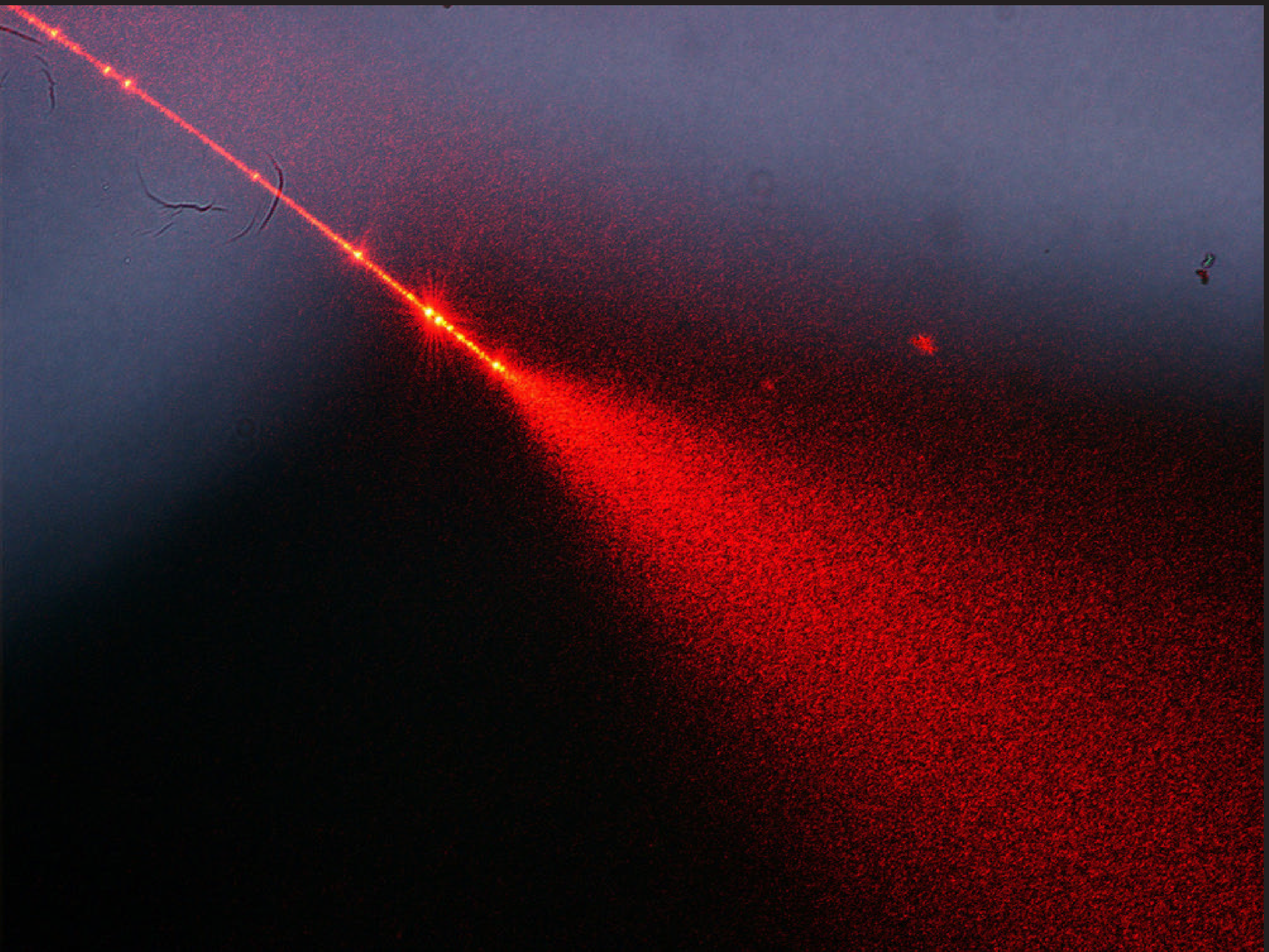
What is 'nanotechnology'?

The fabrication of devices of nanometer size

1 mm = one millimeter

(one thousandth of a meter)

pin head



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21 April 2007, 2:30 pm

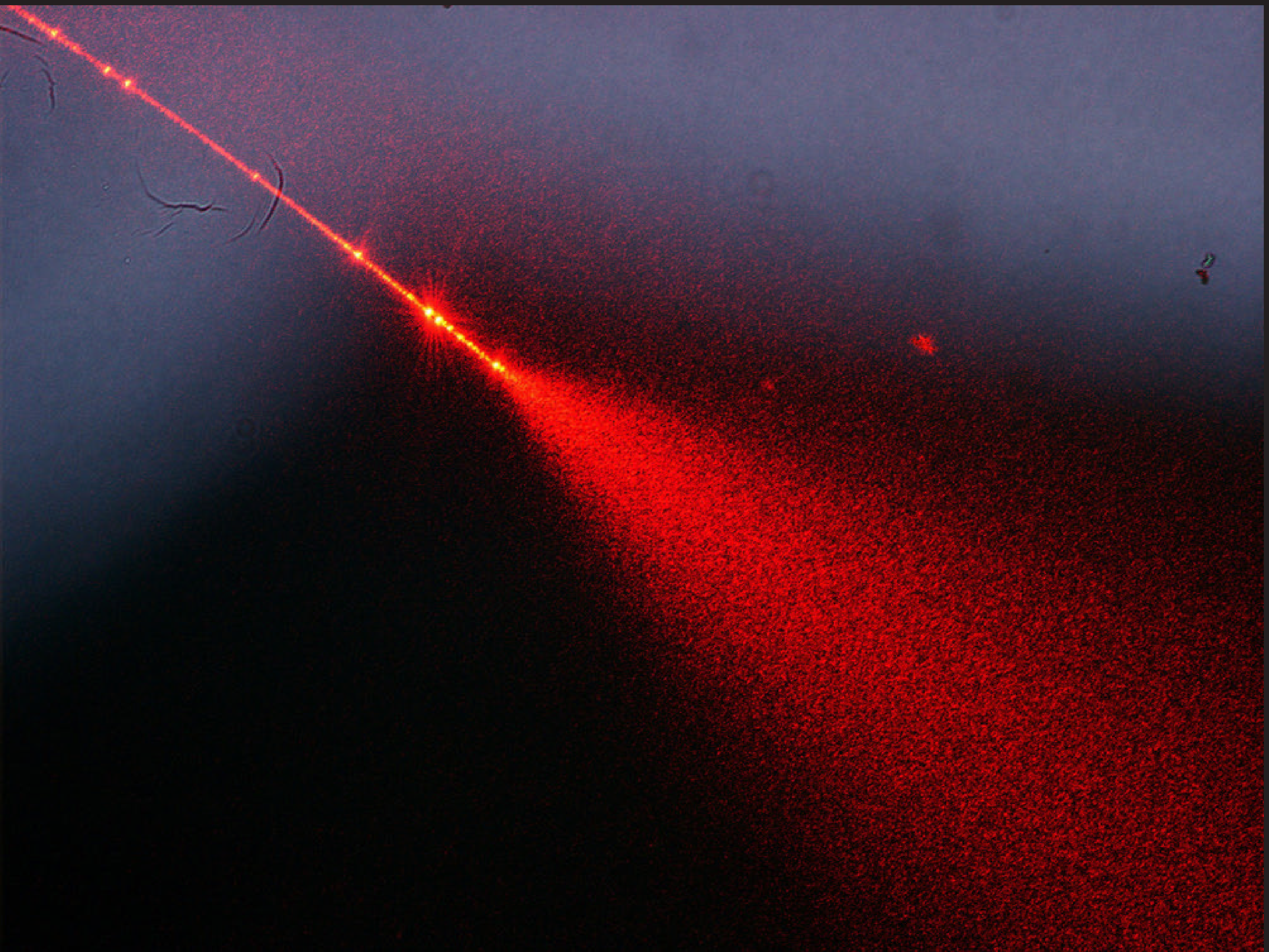
What is 'nanotechnology'?

The fabrication of devices of nanometer size

1 μm = one micrometer

(one millionth of a meter)

red blood cell



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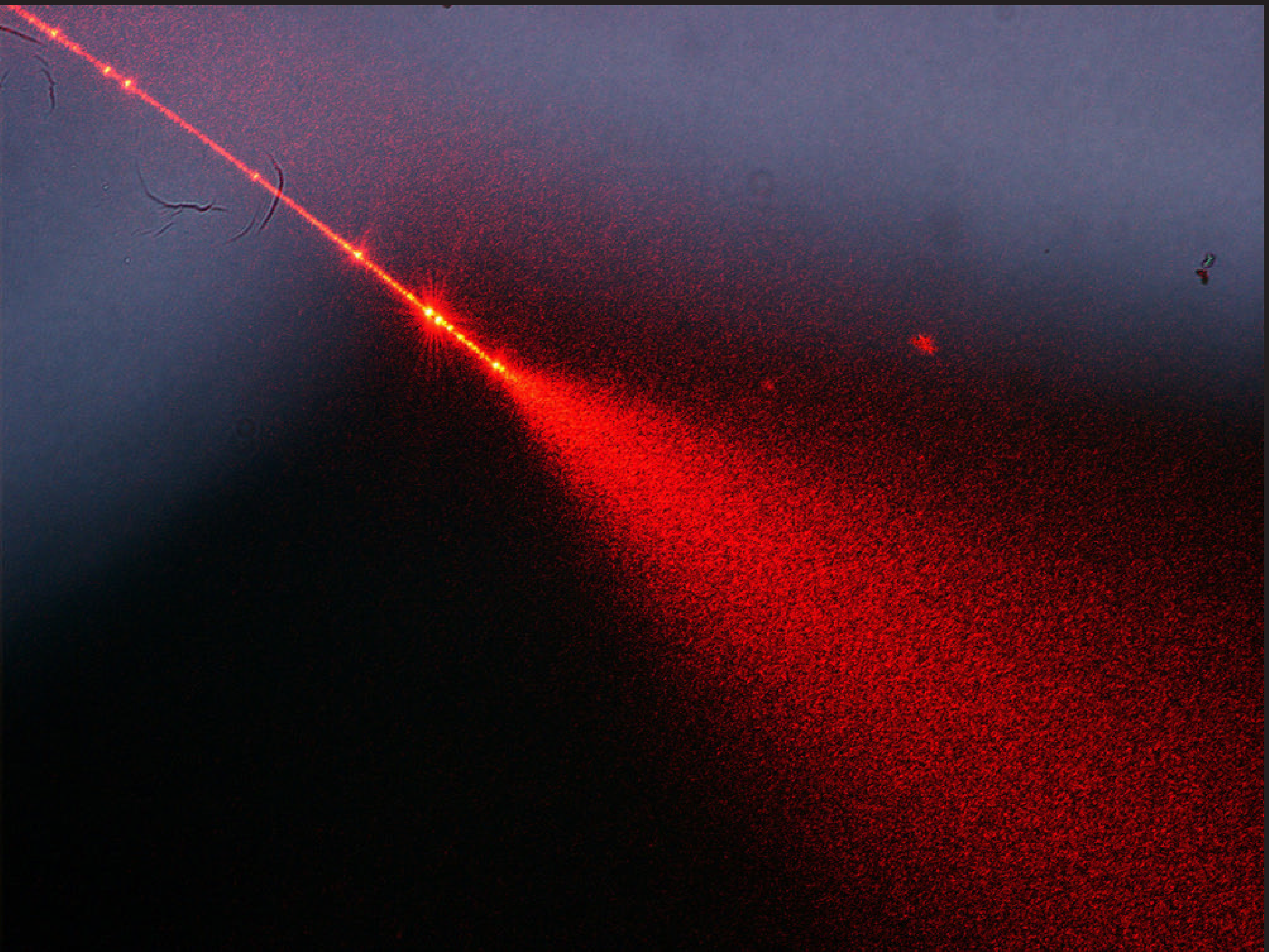
What is ‘nanotechnology’?

The fabrication of devices of nanometer size

1 nm = one nanometer

(one billionth of a meter)

a virus



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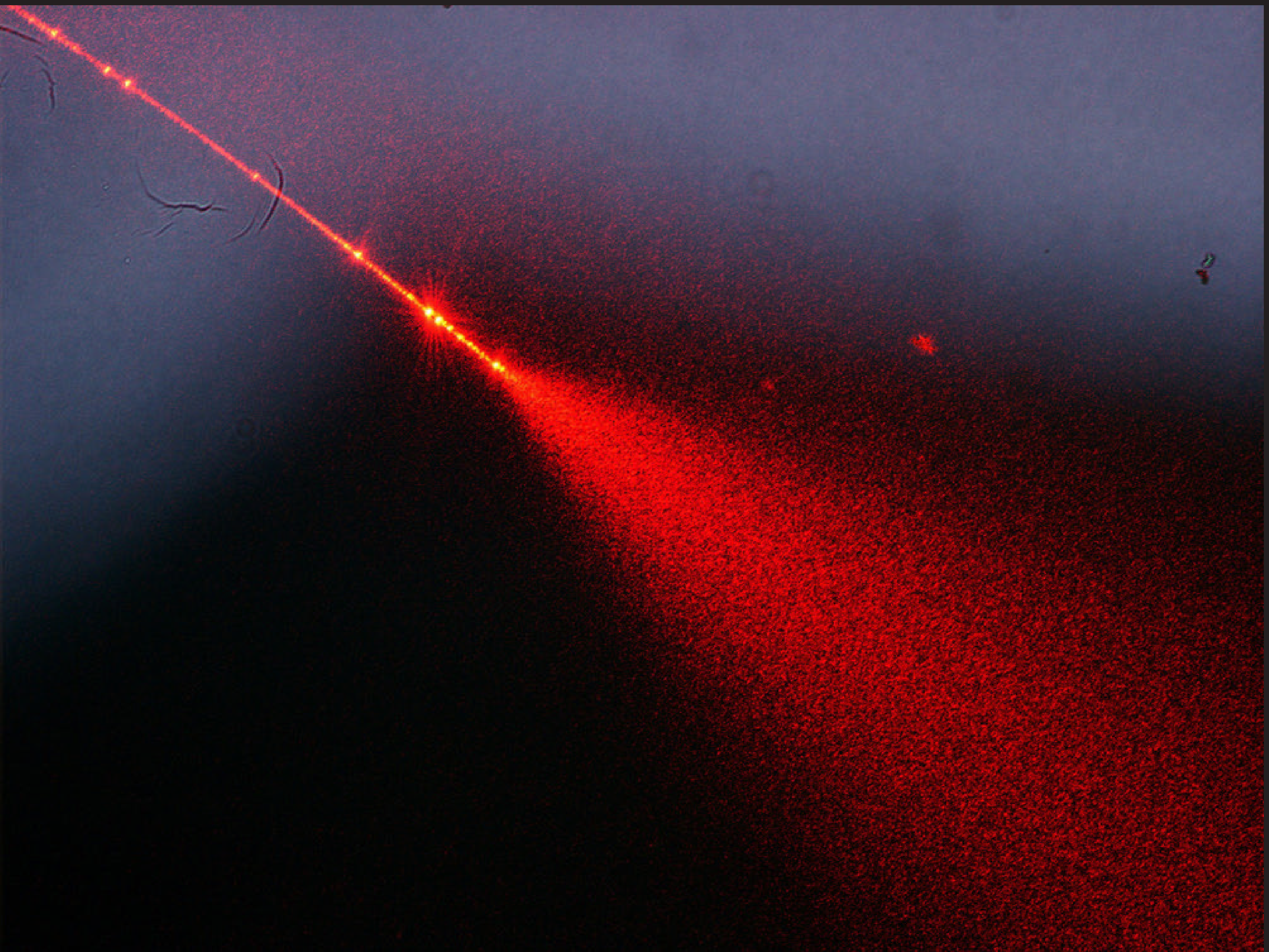
Nanotechnology:

The fabrication of devices on the 1–100 nm scale

1 nm = one nanometer

(one billionth of a meter)

a virus



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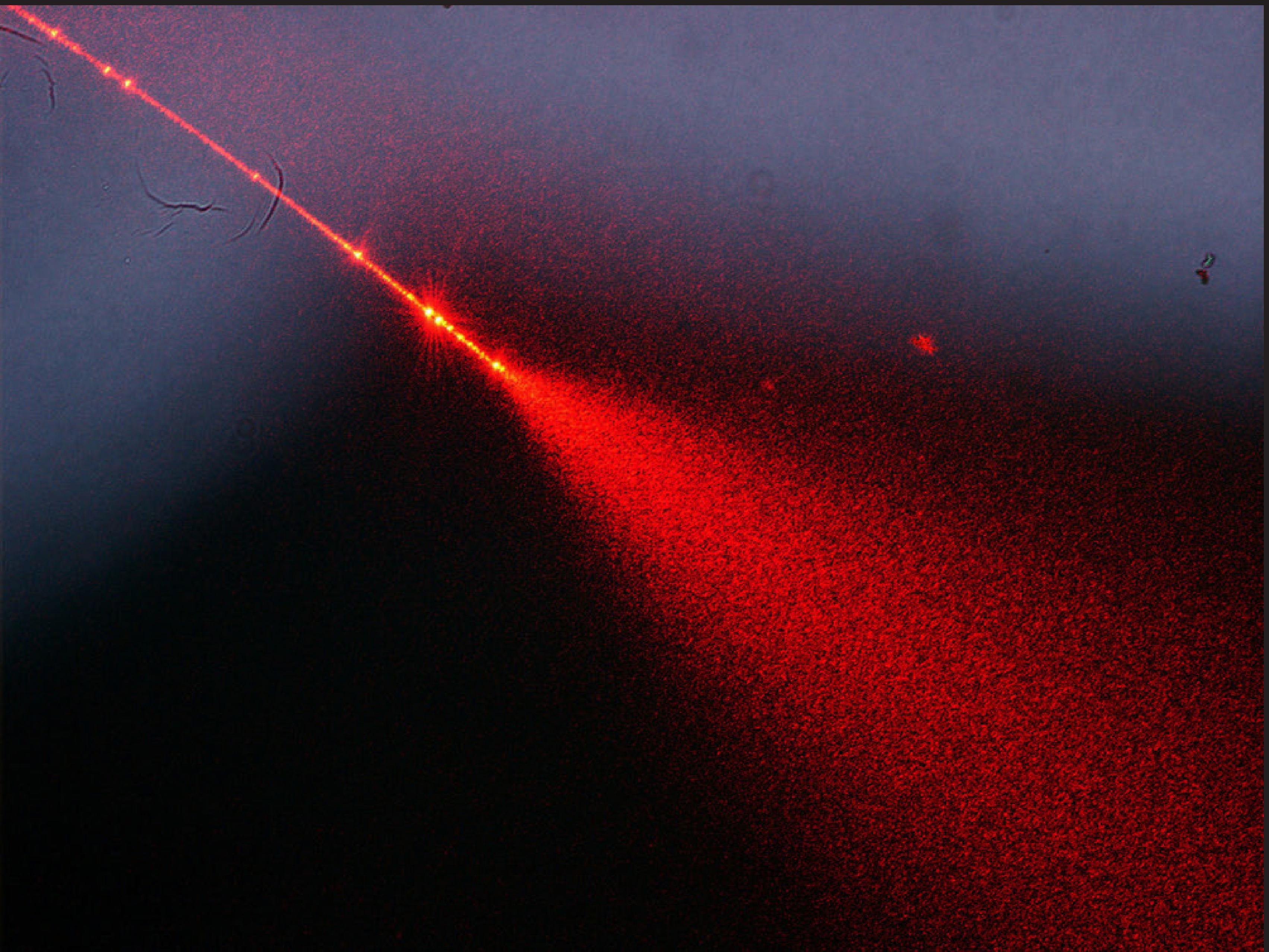
21 April 2007, 2:30 pm

Nanotechnology:

The fabrication of devices on the 1–100 nm scale

Guiding light:

Transporting a light signal through a structure that confines the light



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Guiding light:

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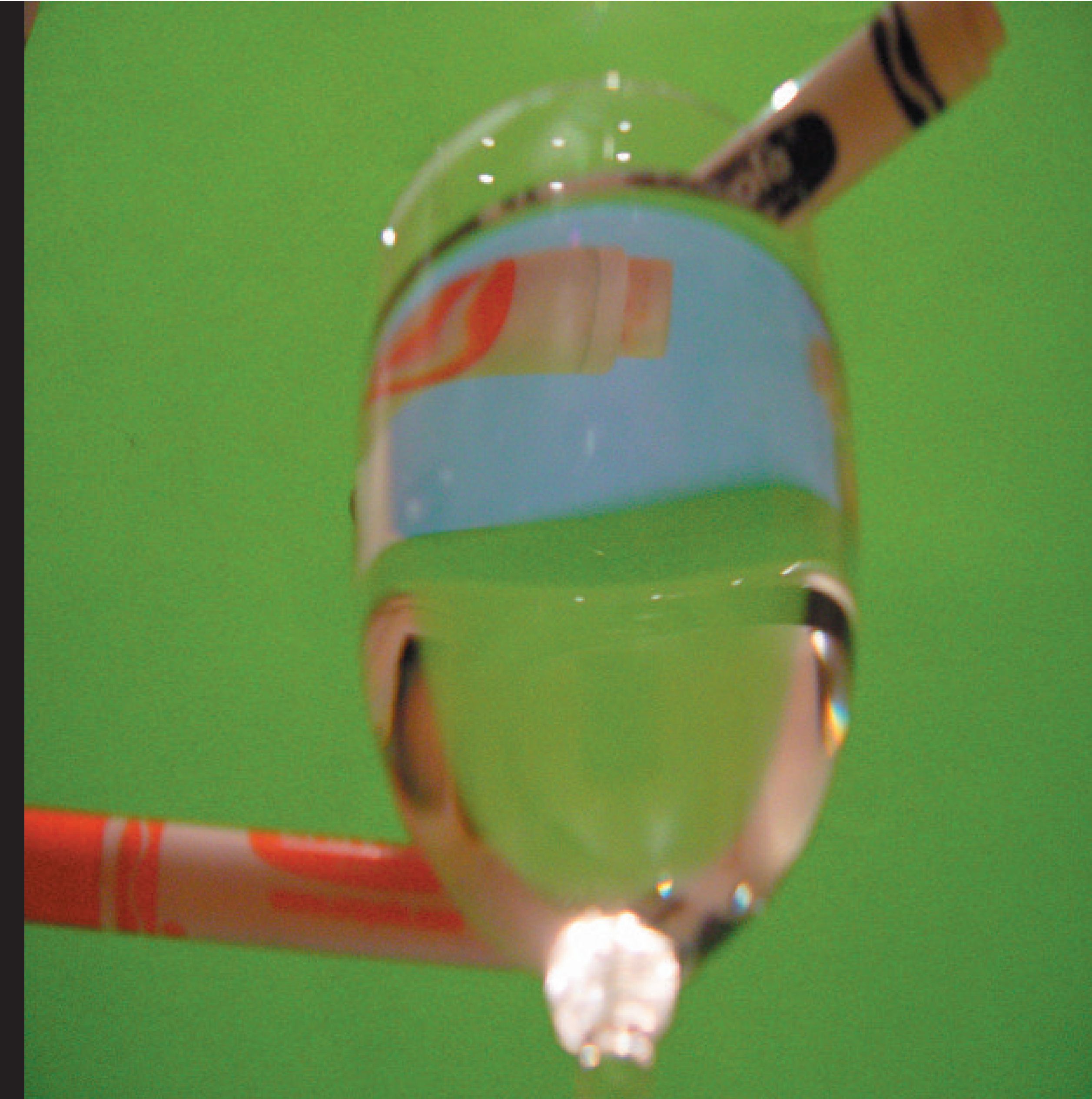



LIBERATOR

Interface between water and air is a perfect one-way mirror!

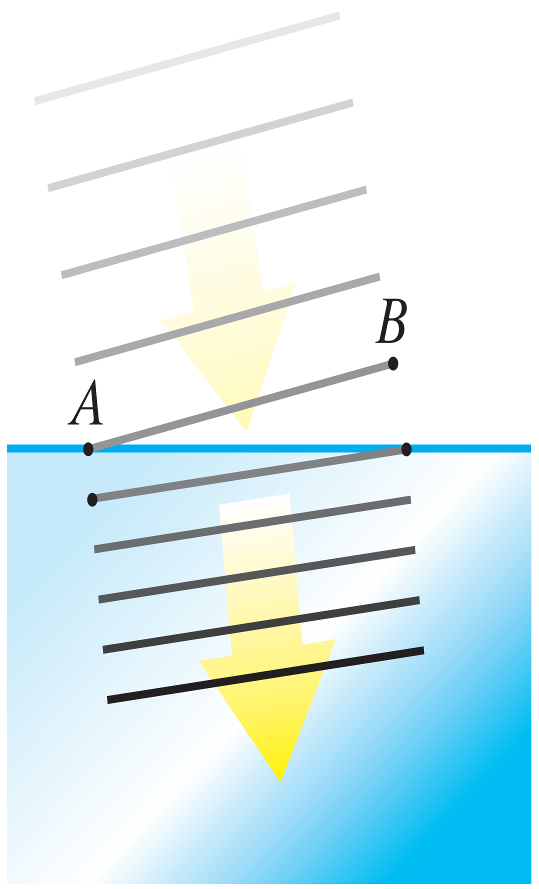
Why?

Why?

Because light travels more slowly in water (or plastic, or glass) than in air

Why?

Because light travels more slowly in water (or plastic, or glass) than in air



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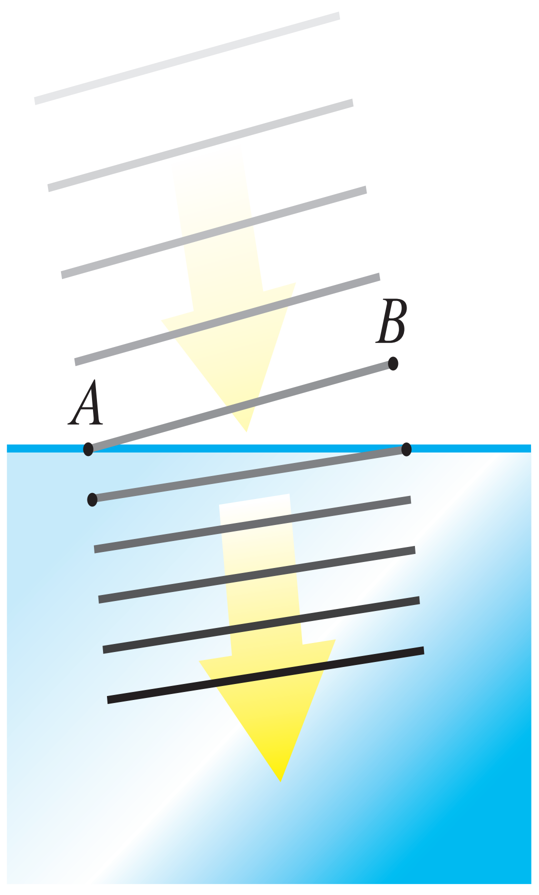
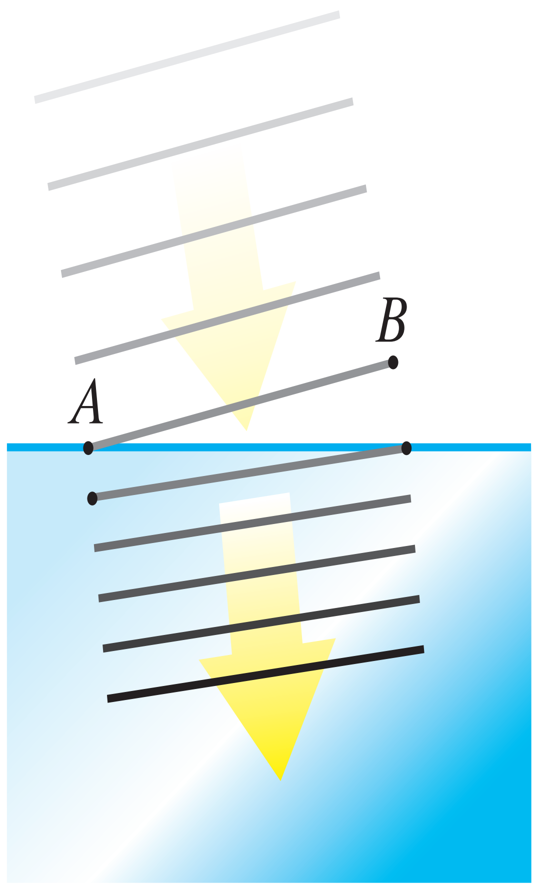
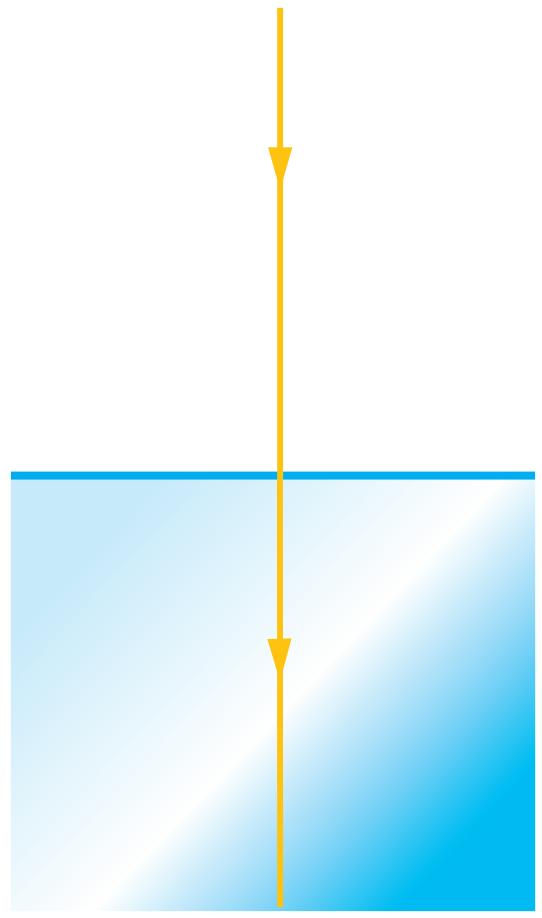


The more angled the incident ray, the stronger the bending





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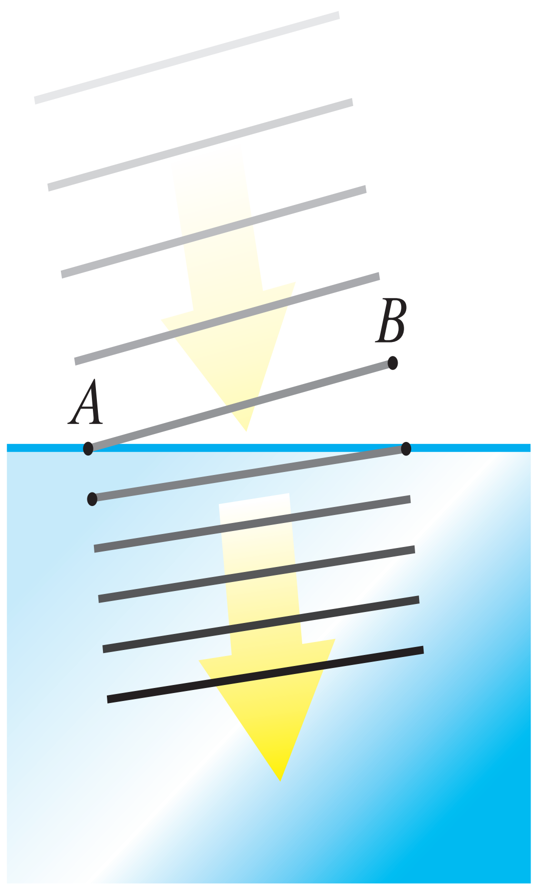
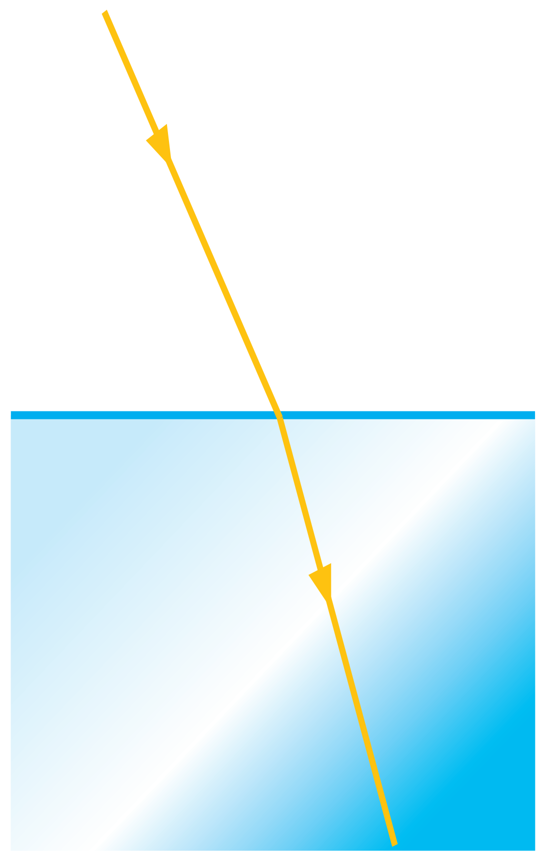
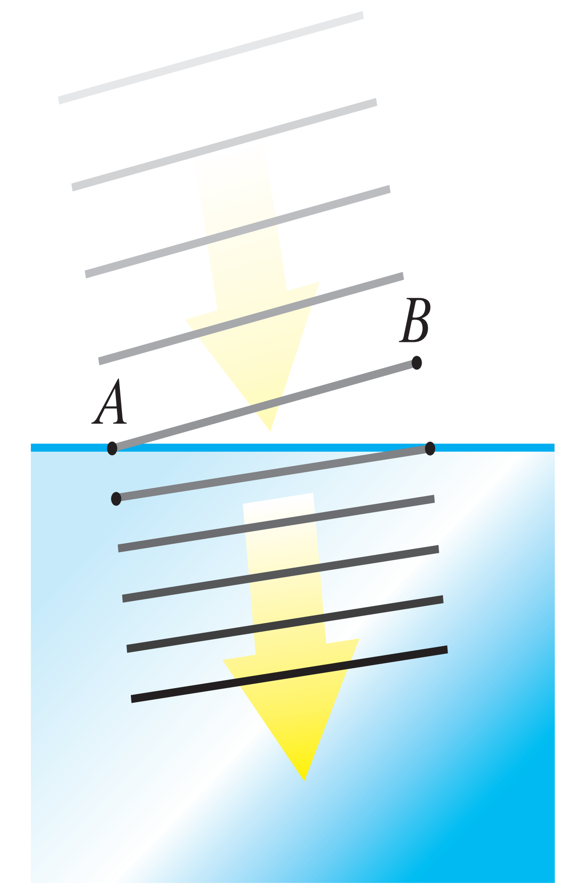
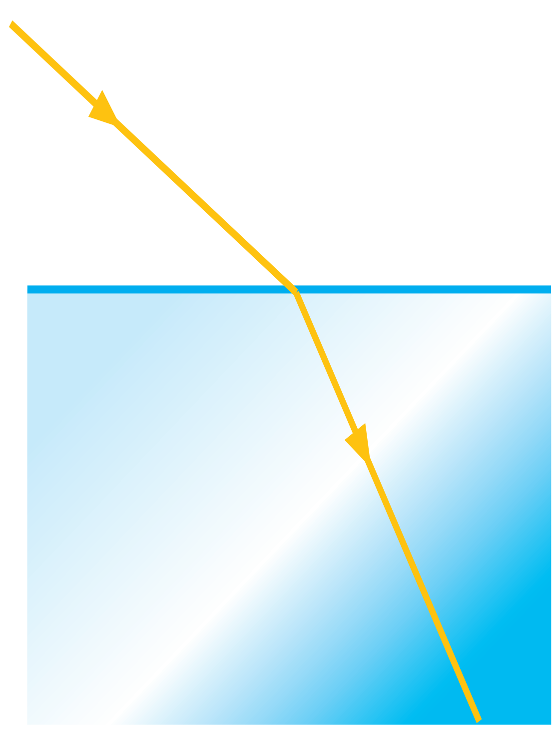




The shallower the incident ray, the stronger the bending





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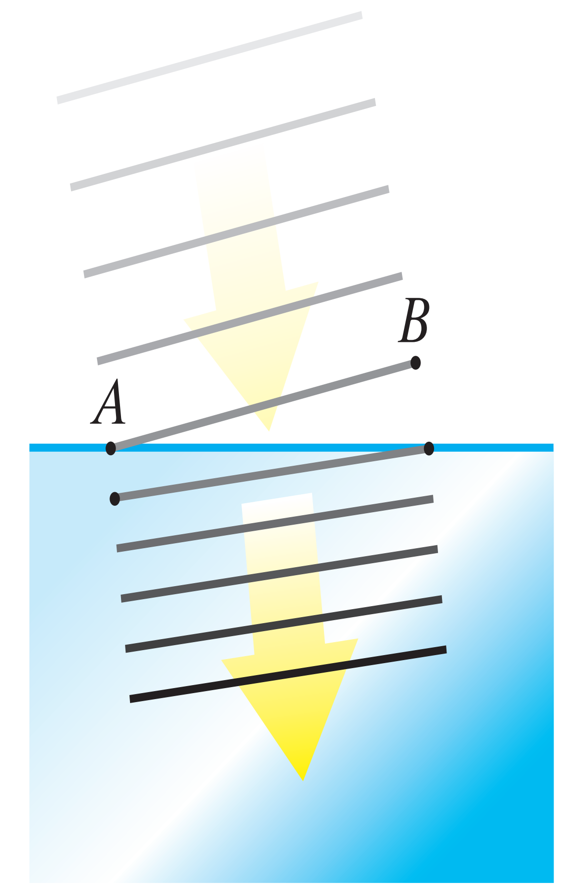
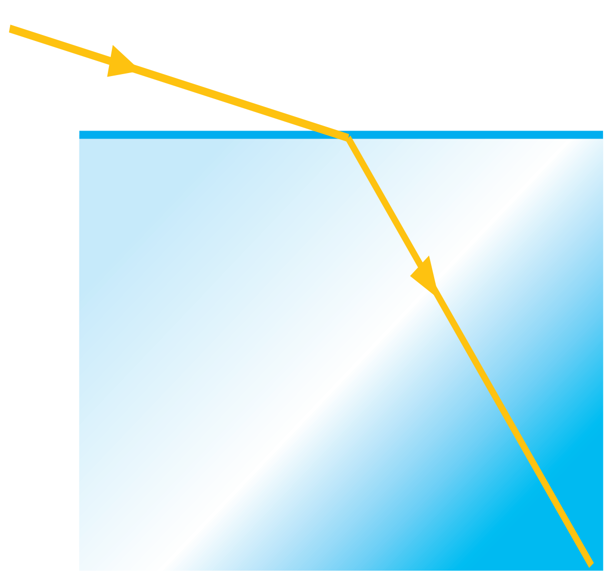
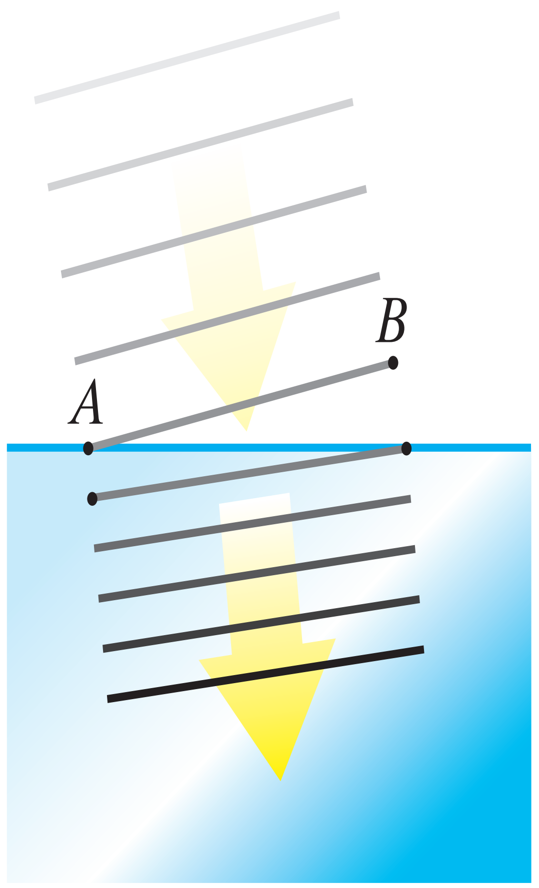
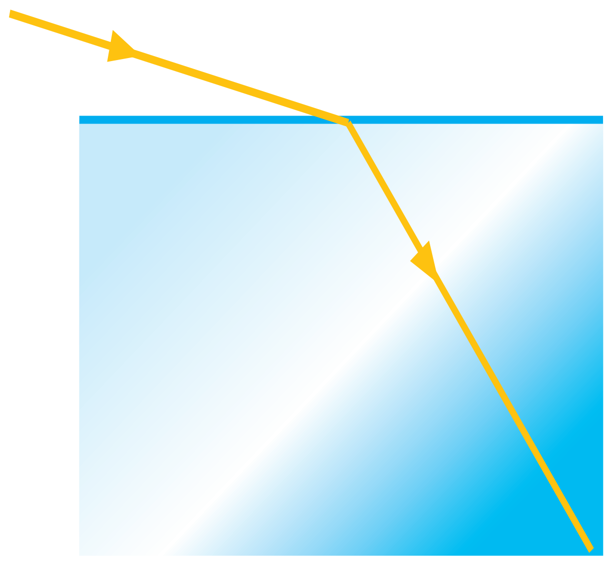




The shallower the incident ray, the stronger the bending

The amount of bending is the same in reverse





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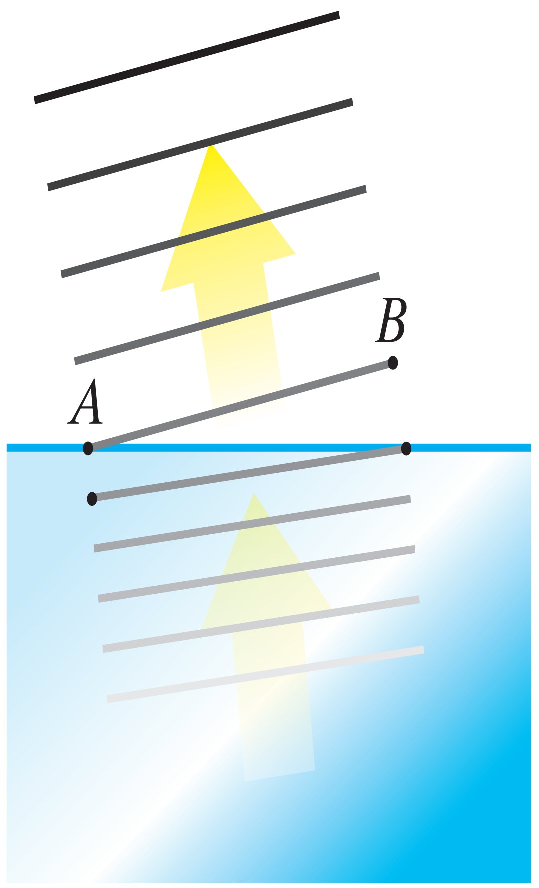

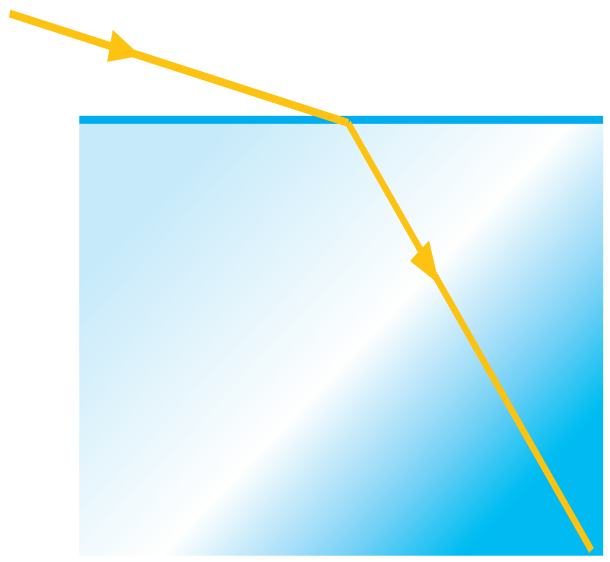

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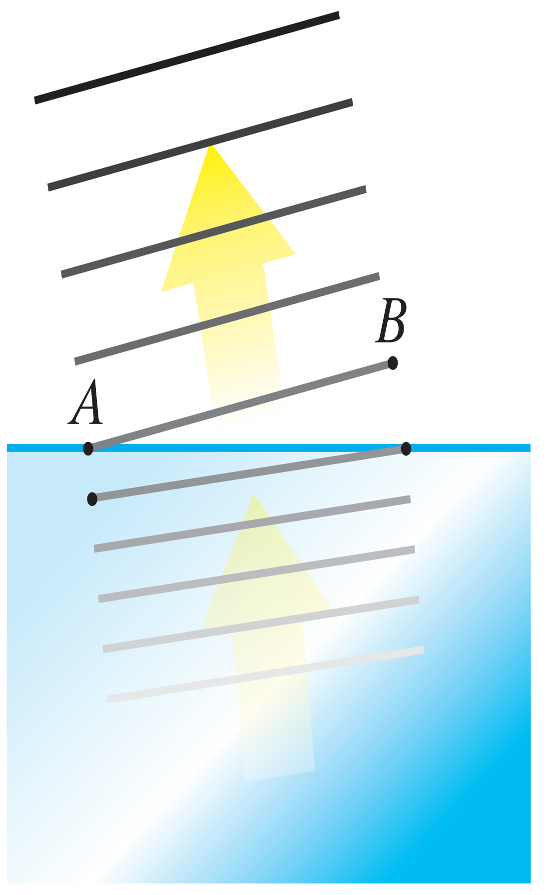

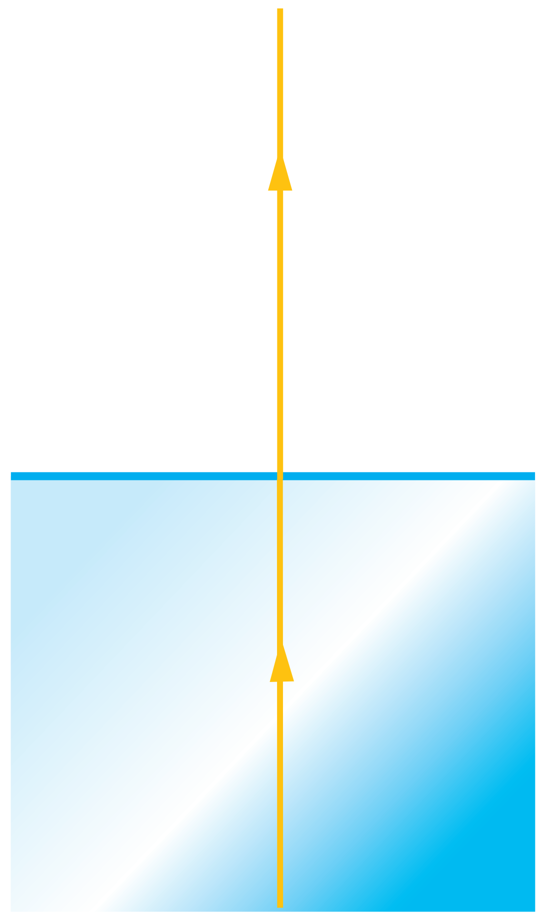

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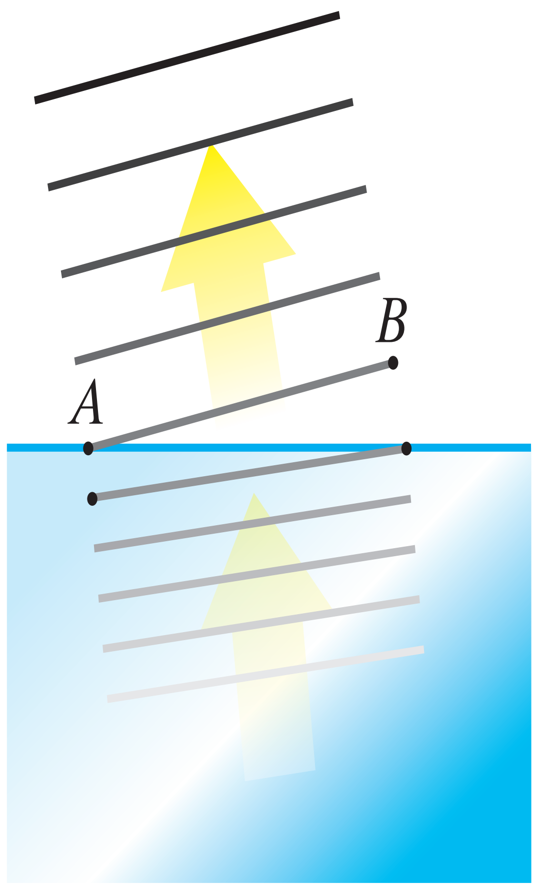

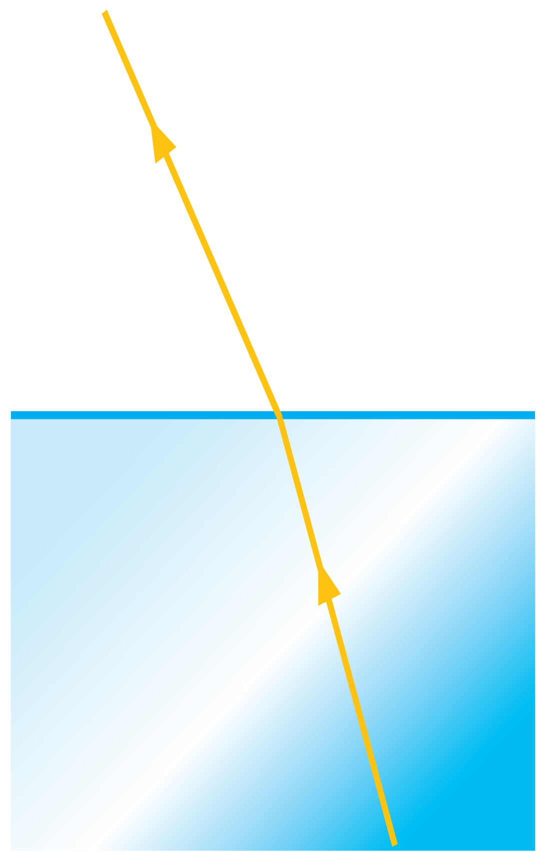

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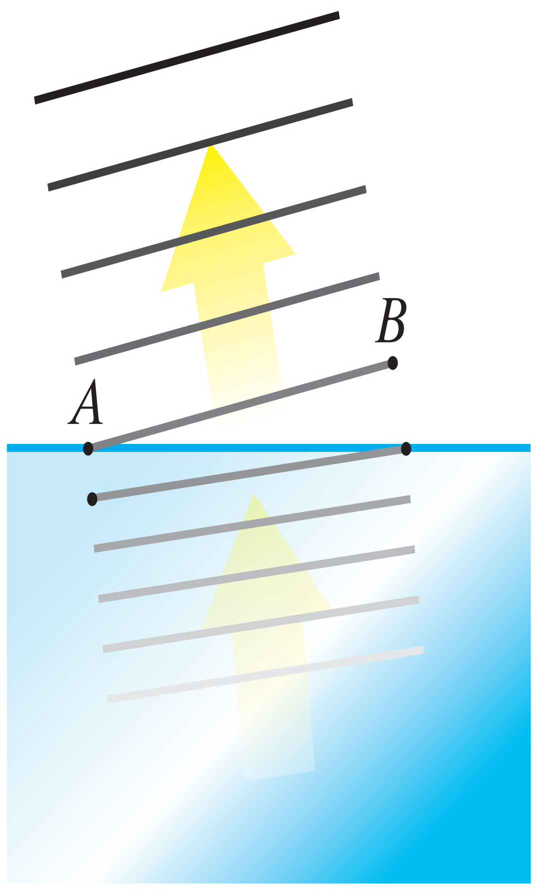

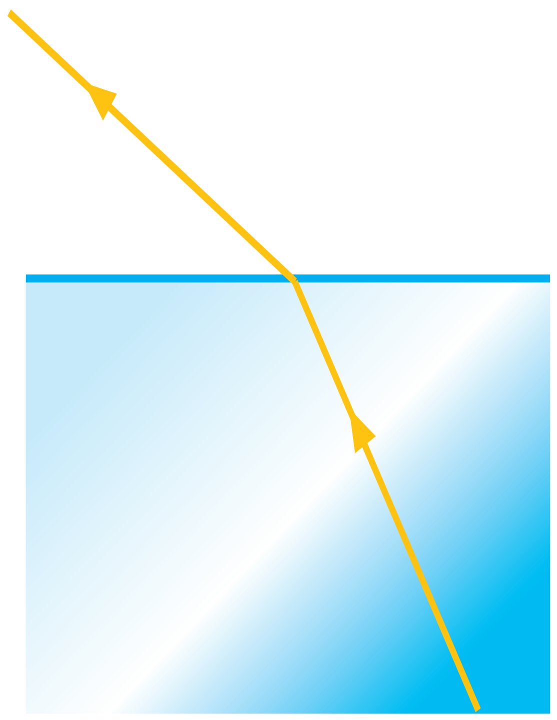

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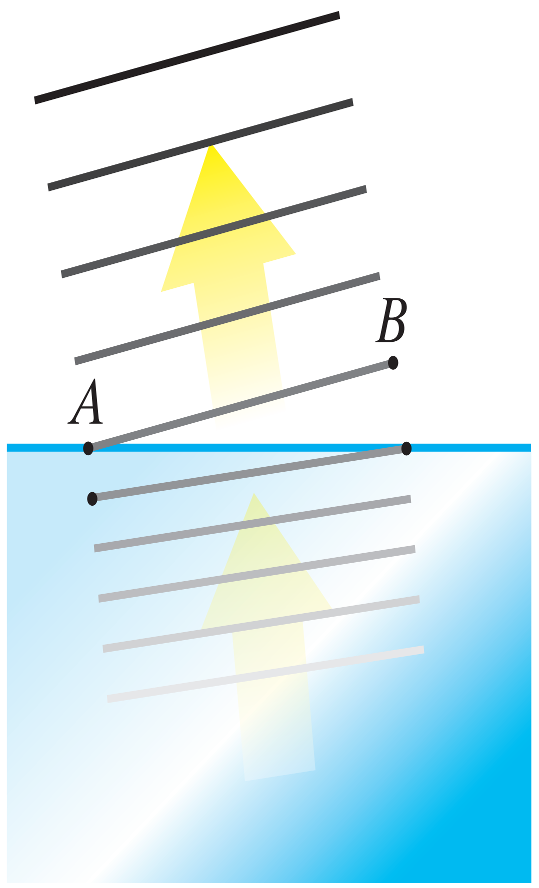

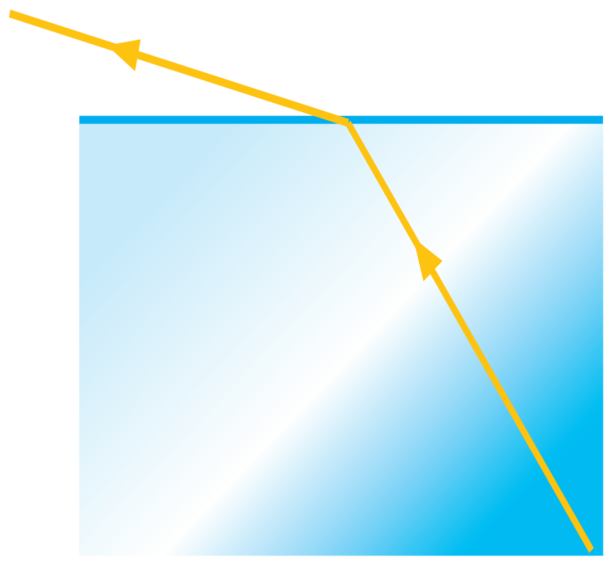

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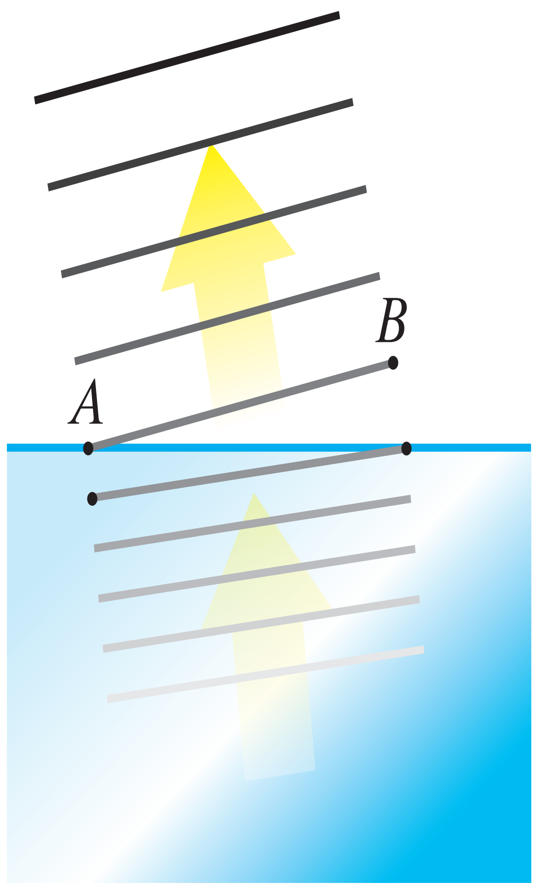
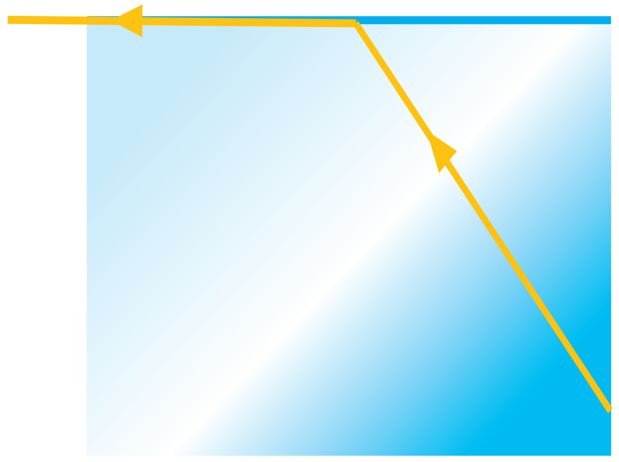
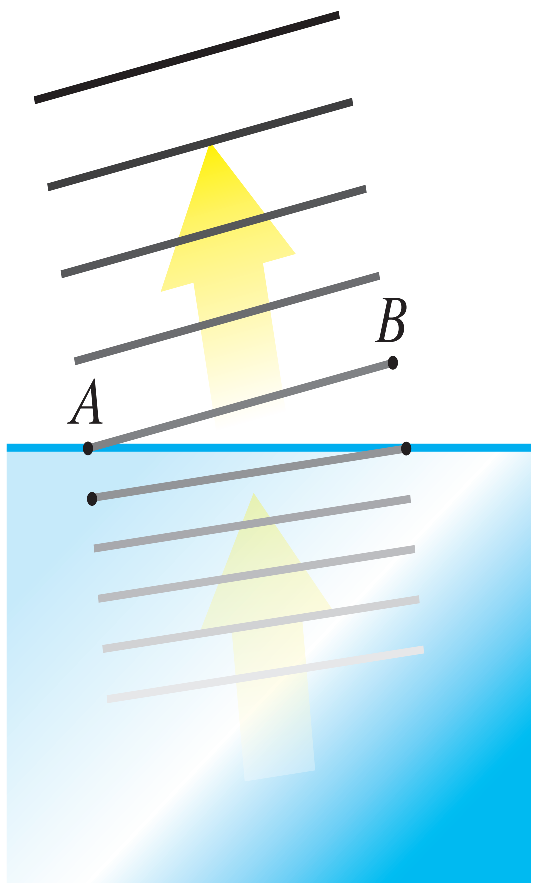
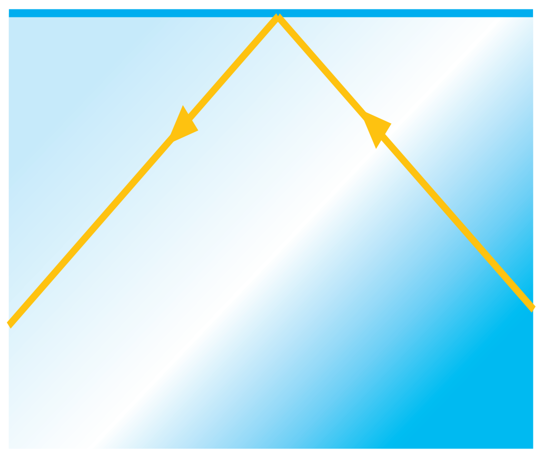




At the 'critical angle', the bent ray travels along the surface

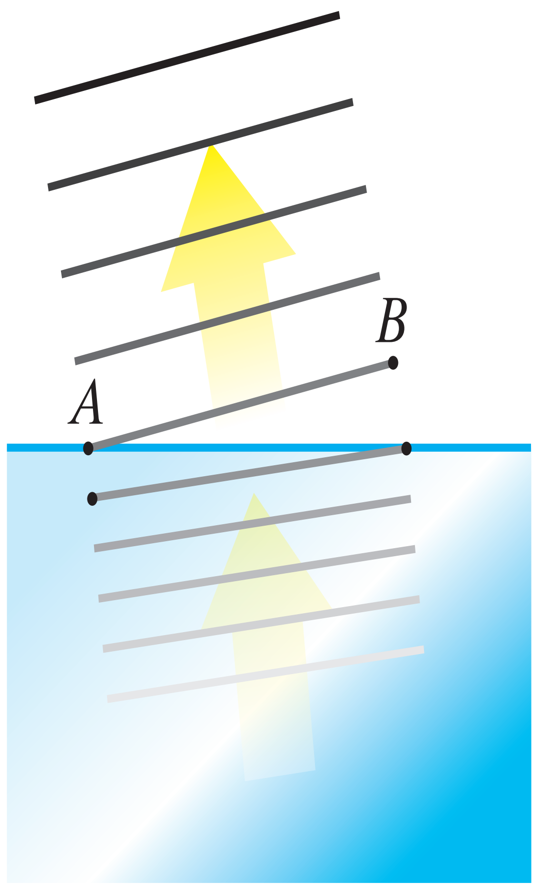
The amount of bending is the same in reverse

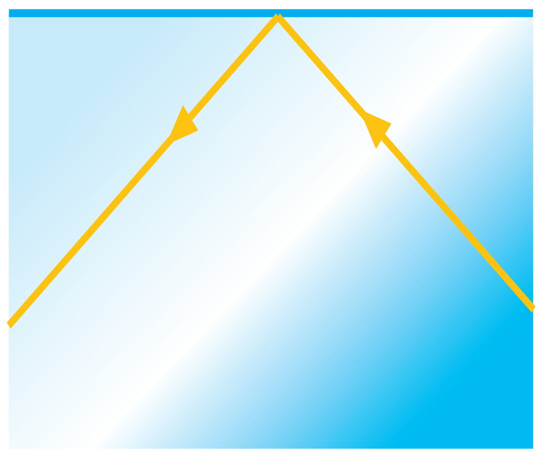




Beyond critical angle: total internal reflection!

Seeing underwater





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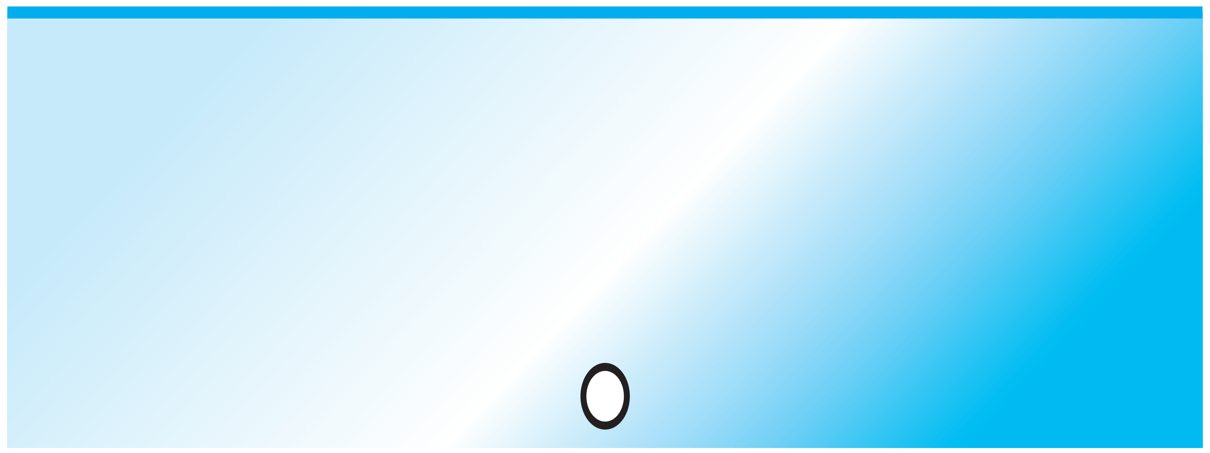

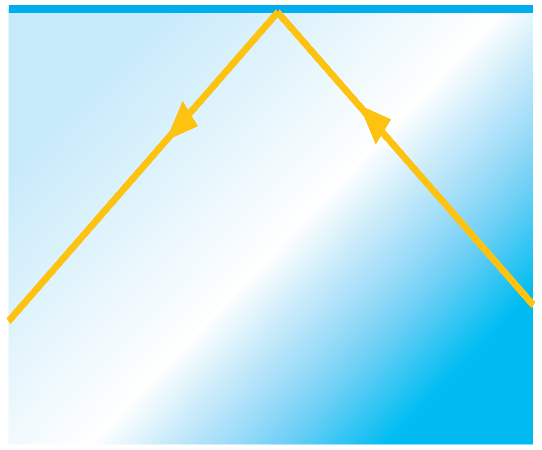

Beyond critical angle:
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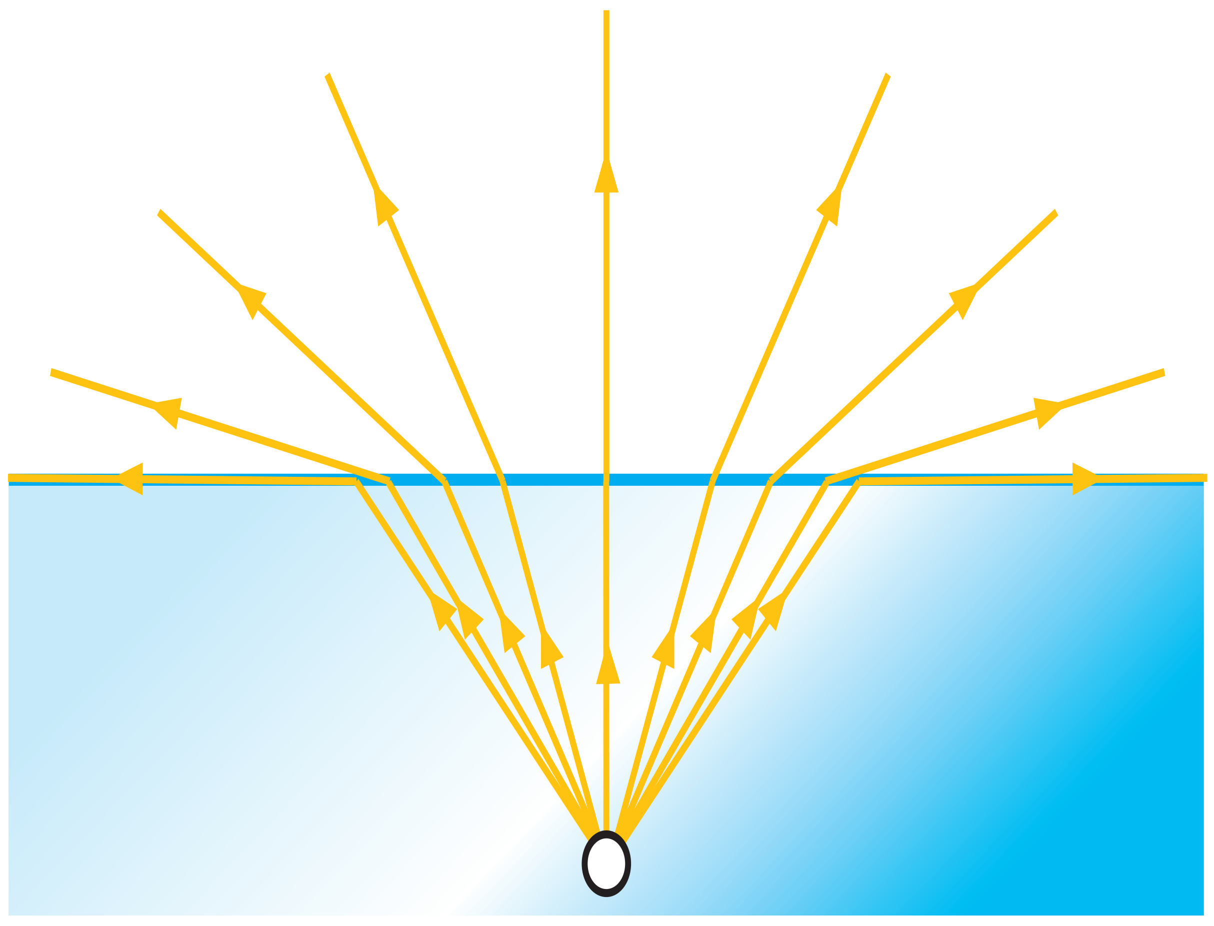
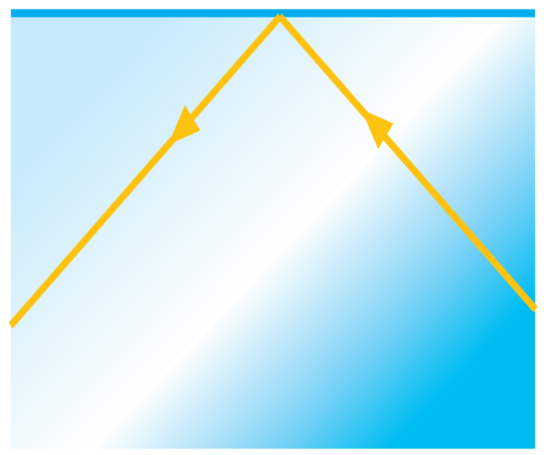
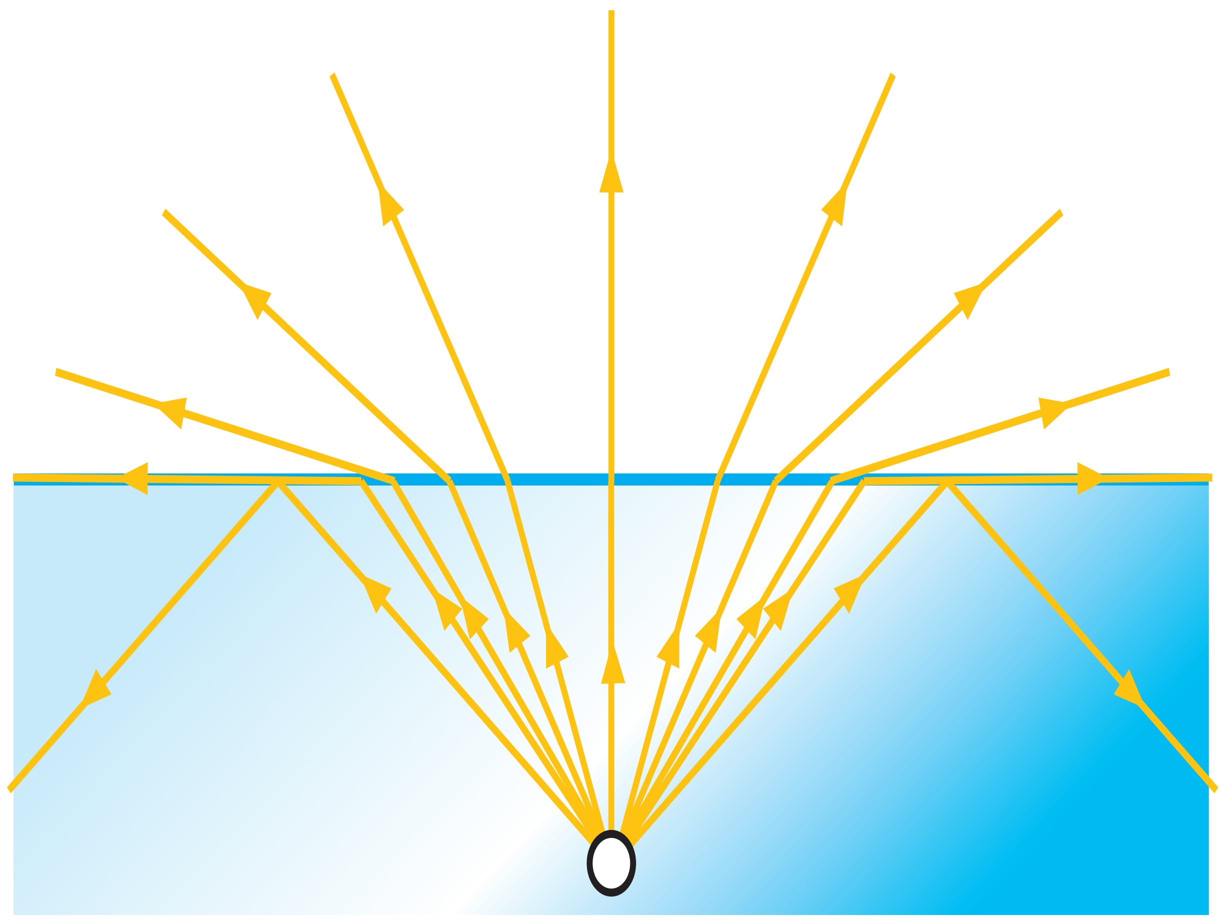
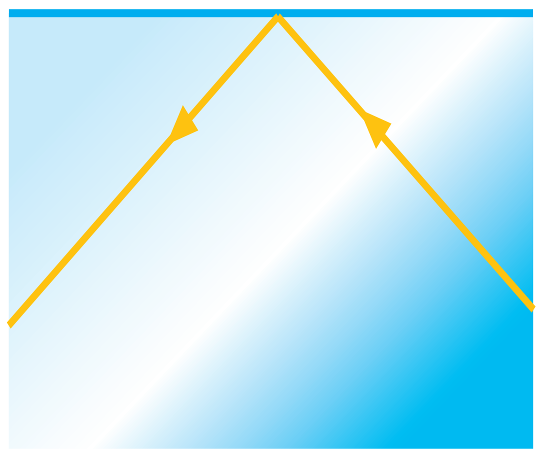




Beyond critical angle: total internal reflection!

Seeing underwater





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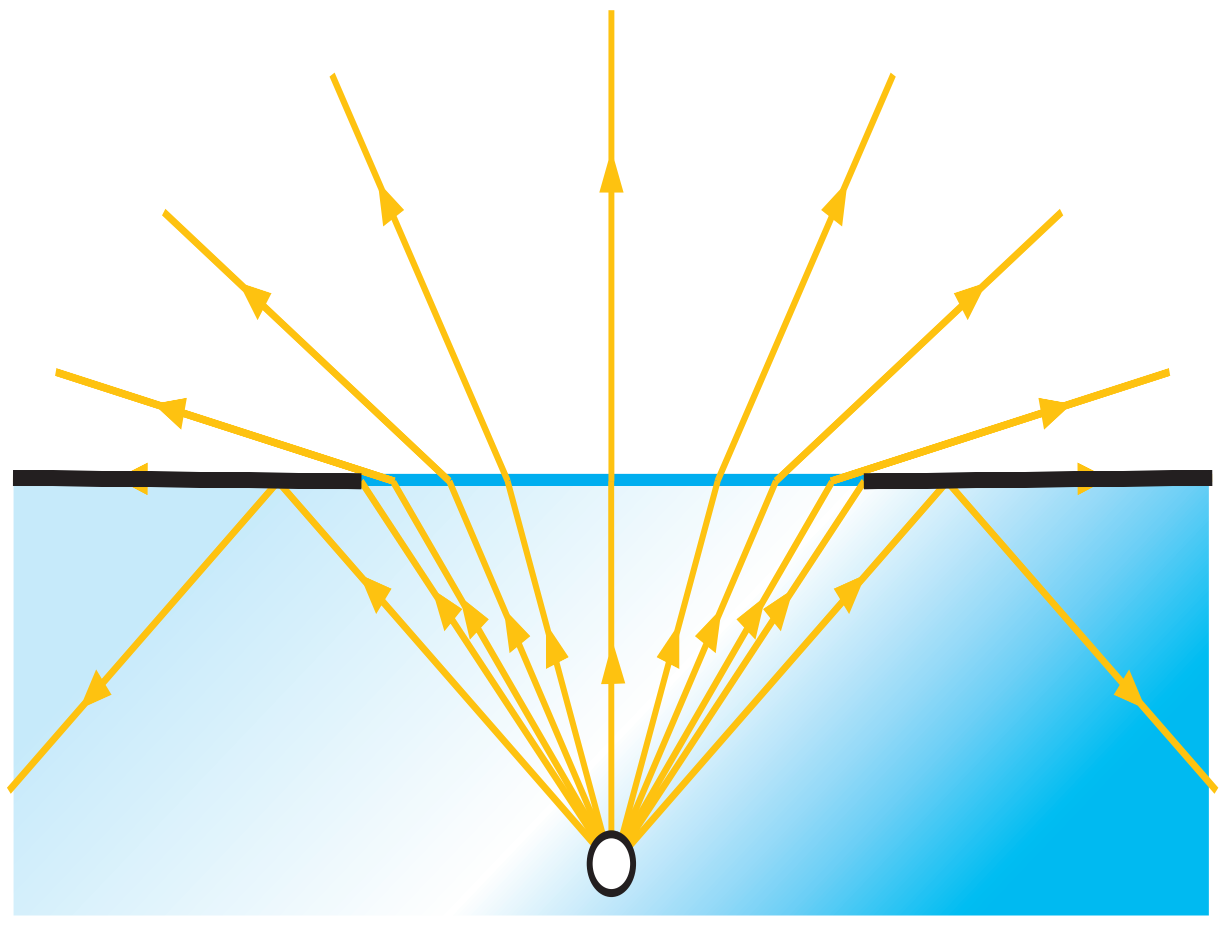

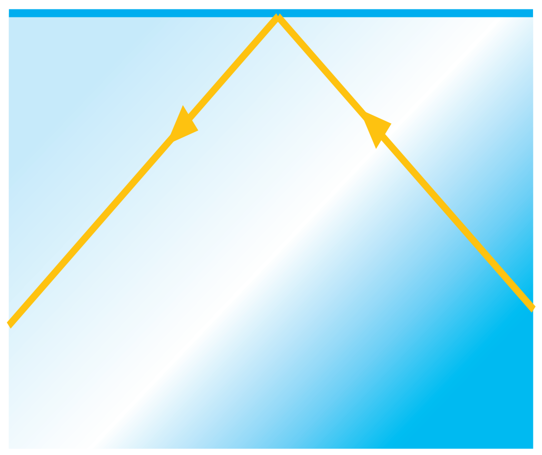

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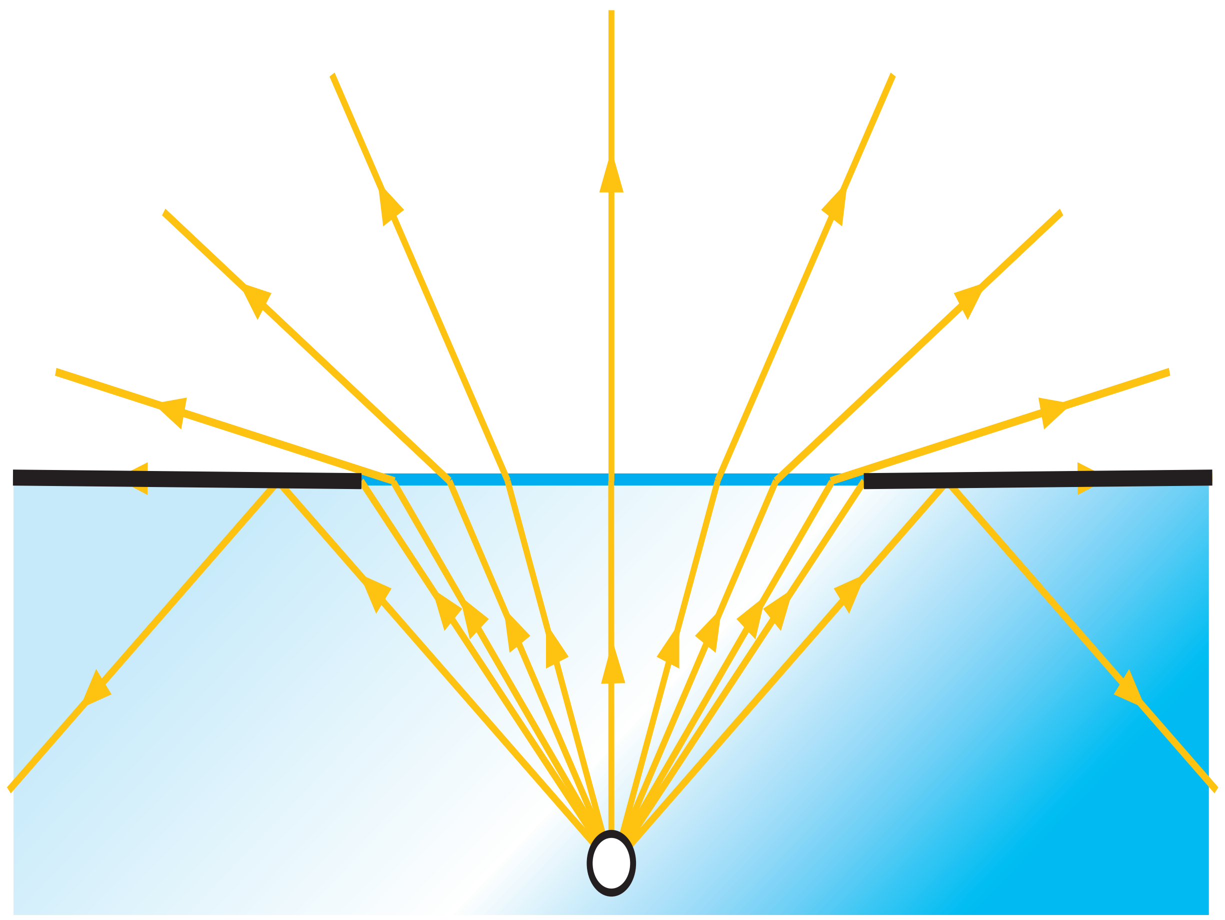

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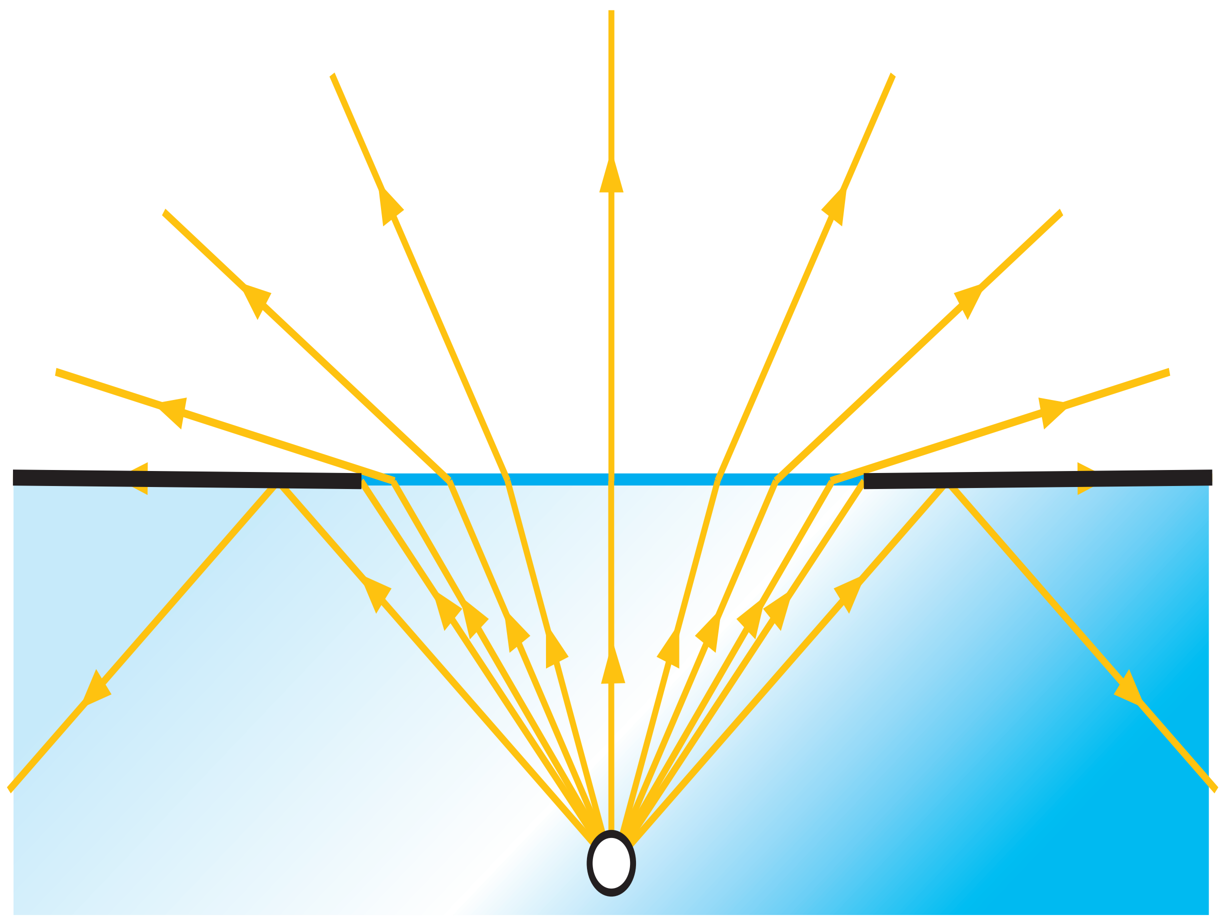
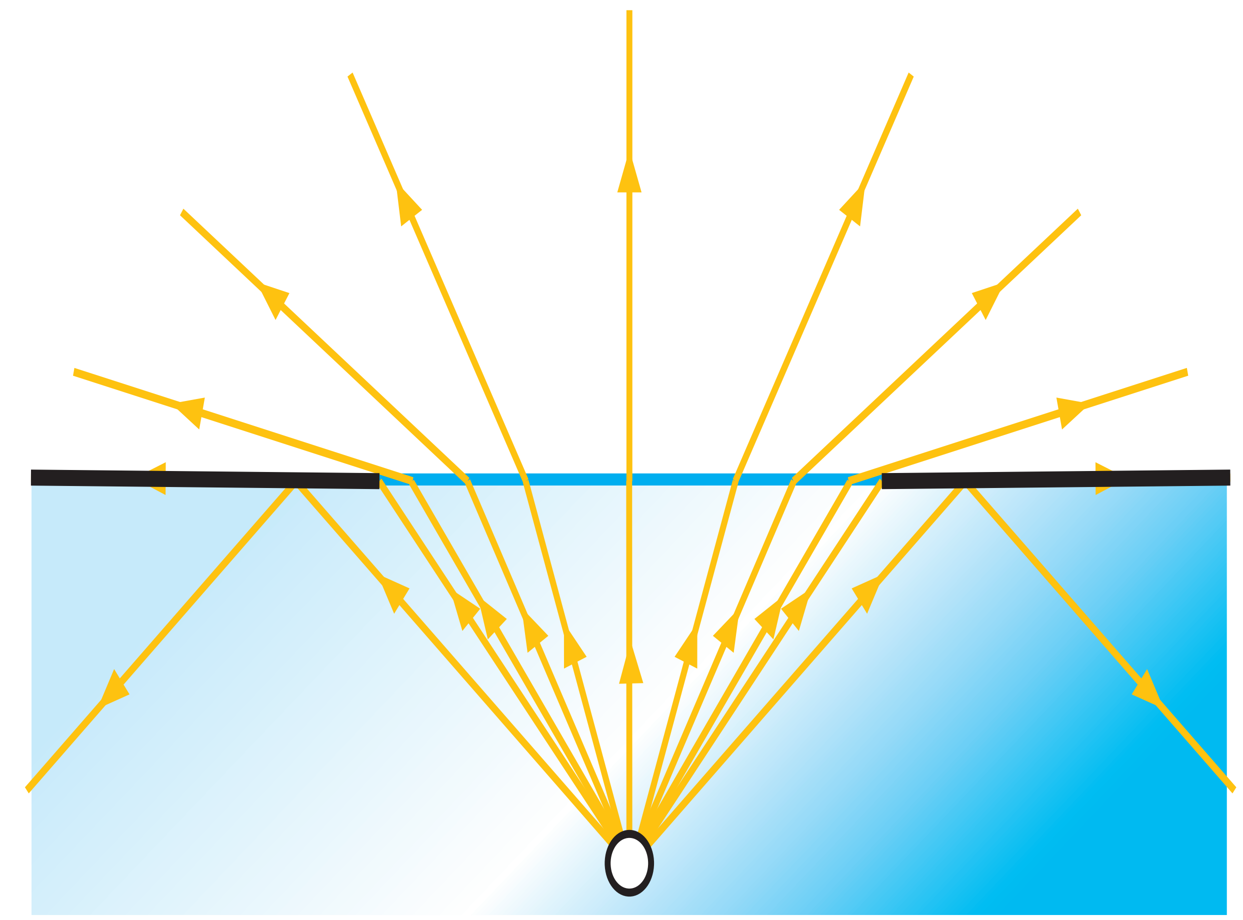
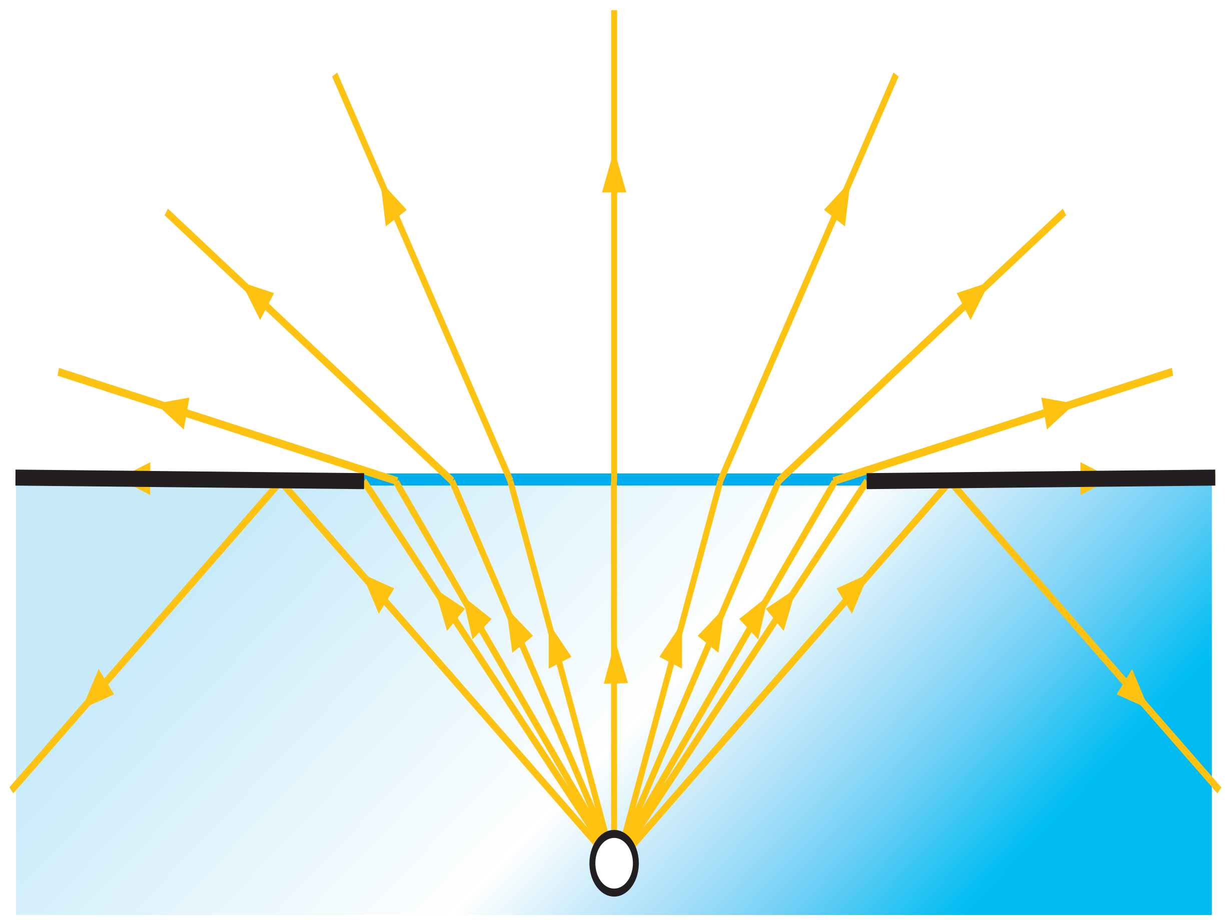




Use total internal reflection to guide light



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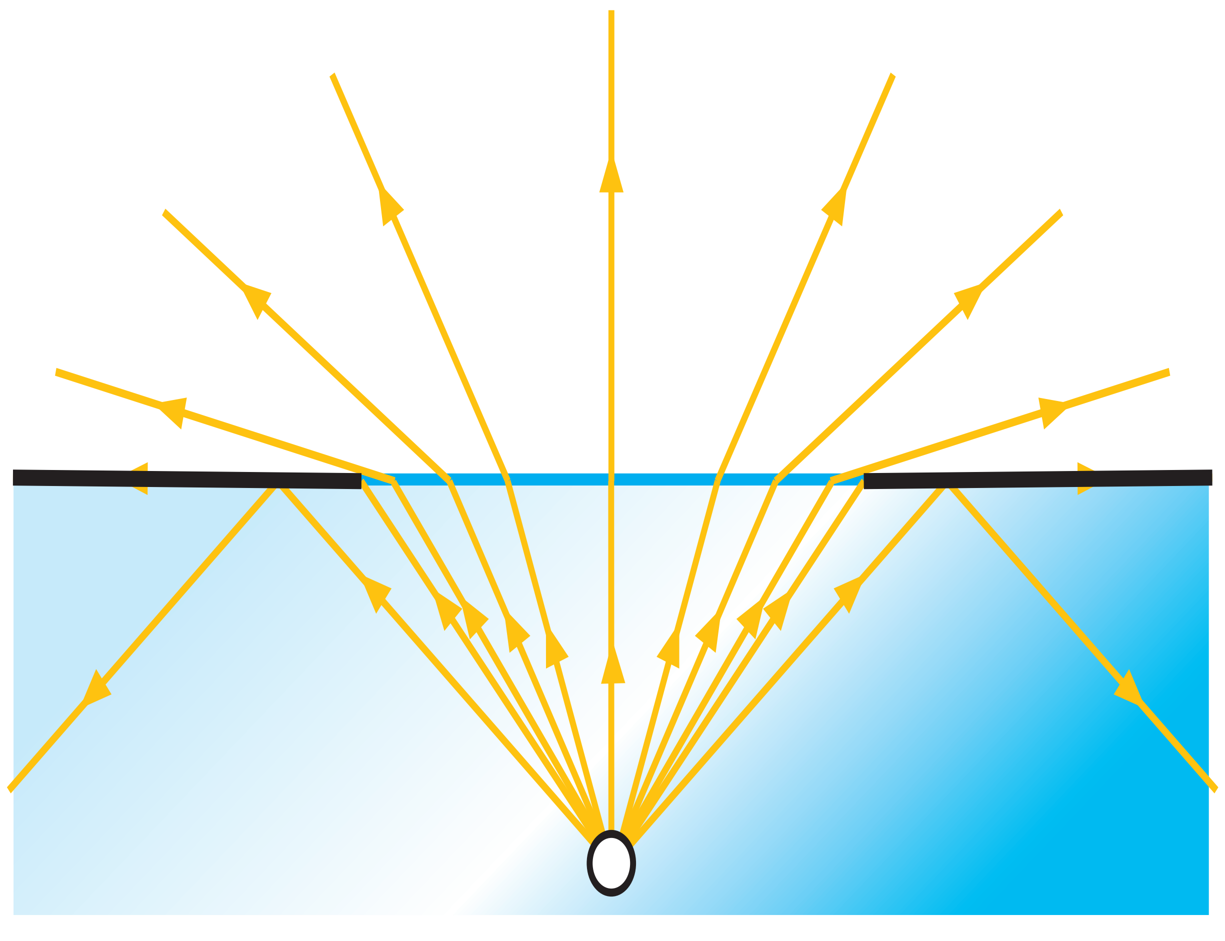

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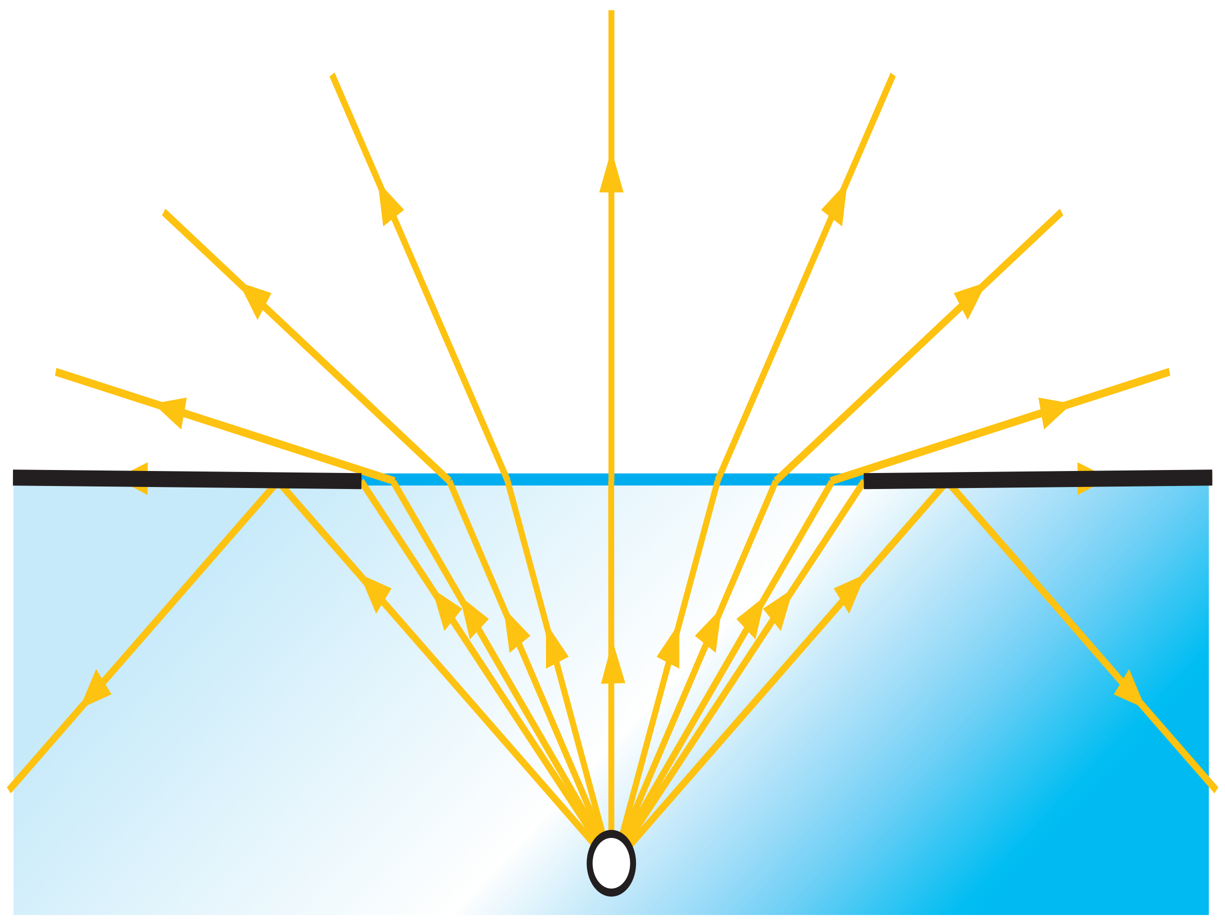

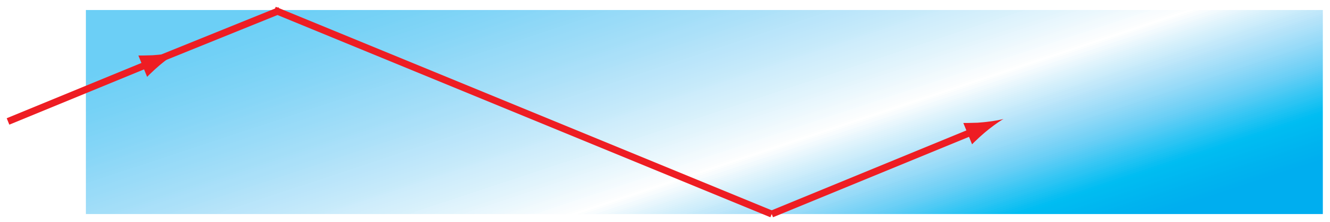

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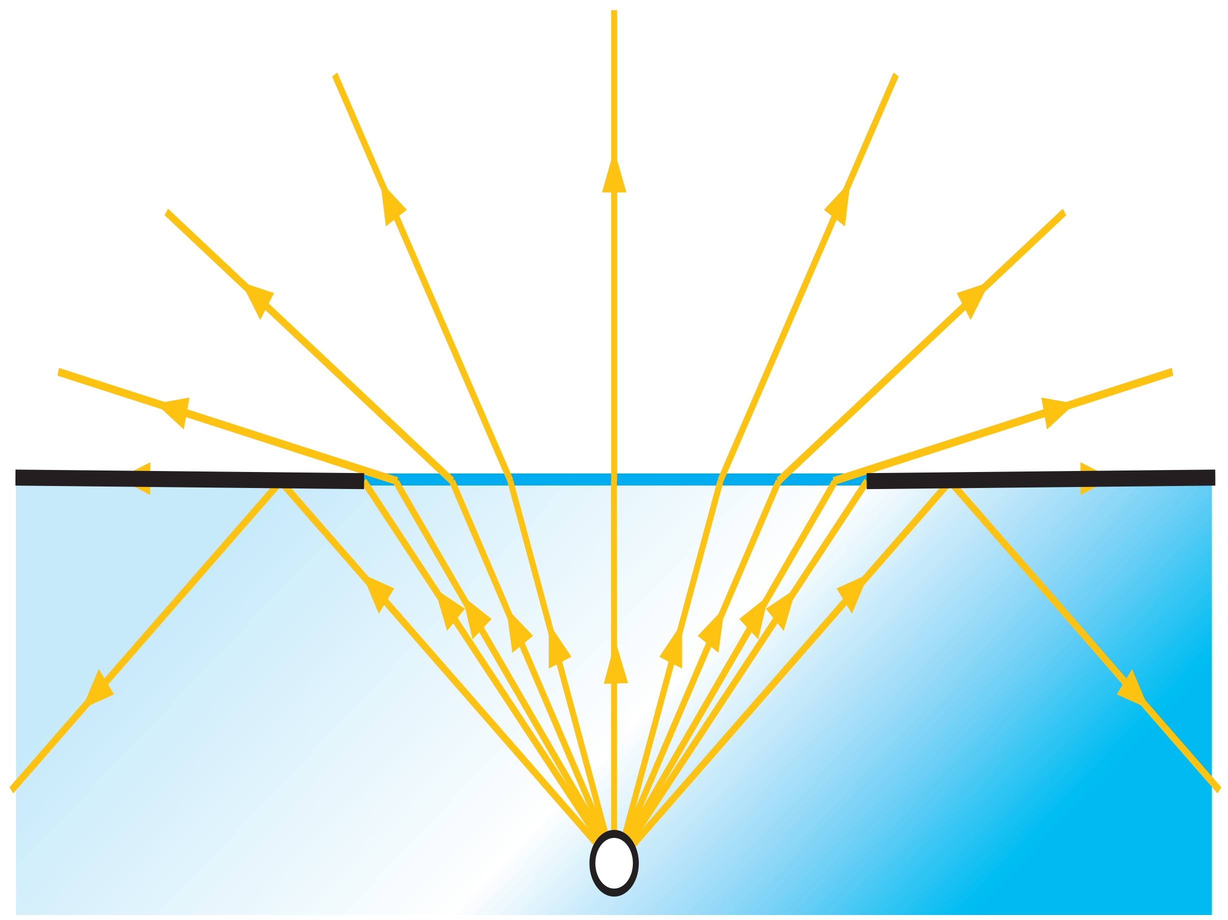
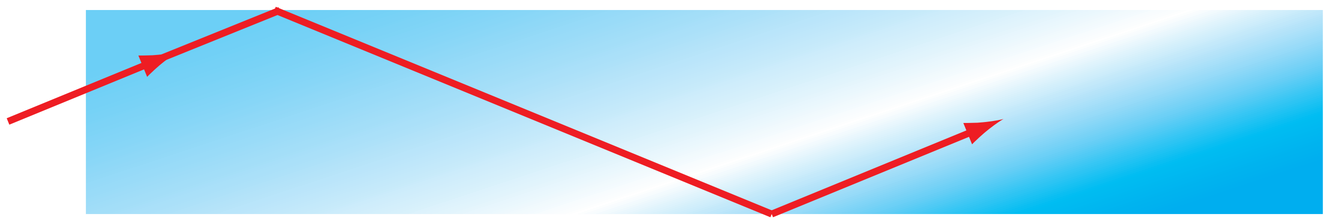
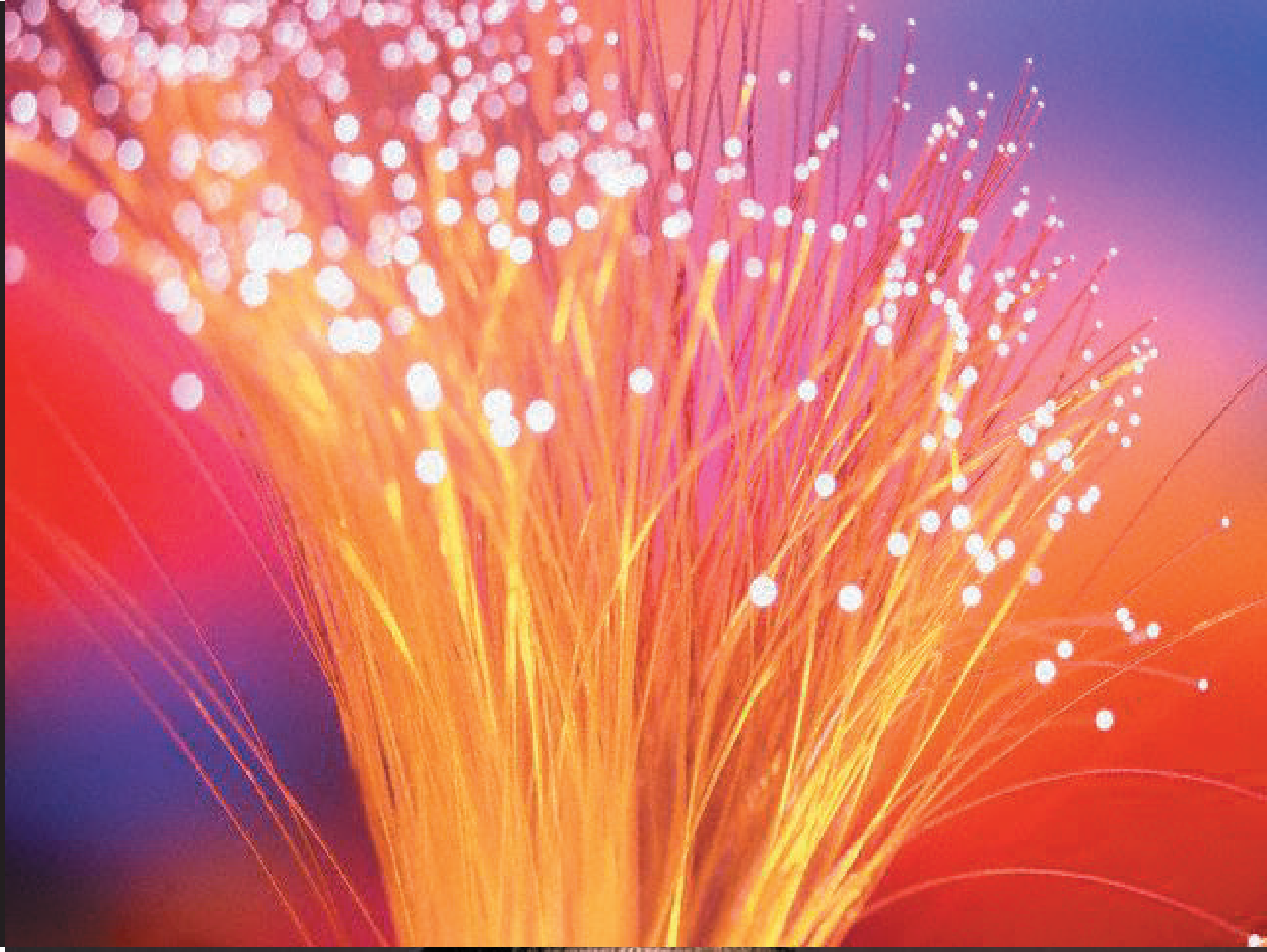
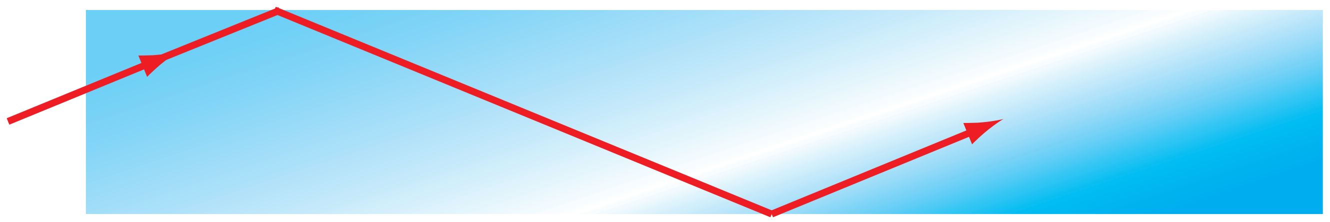




Optical fiber:

a 'hose' for light

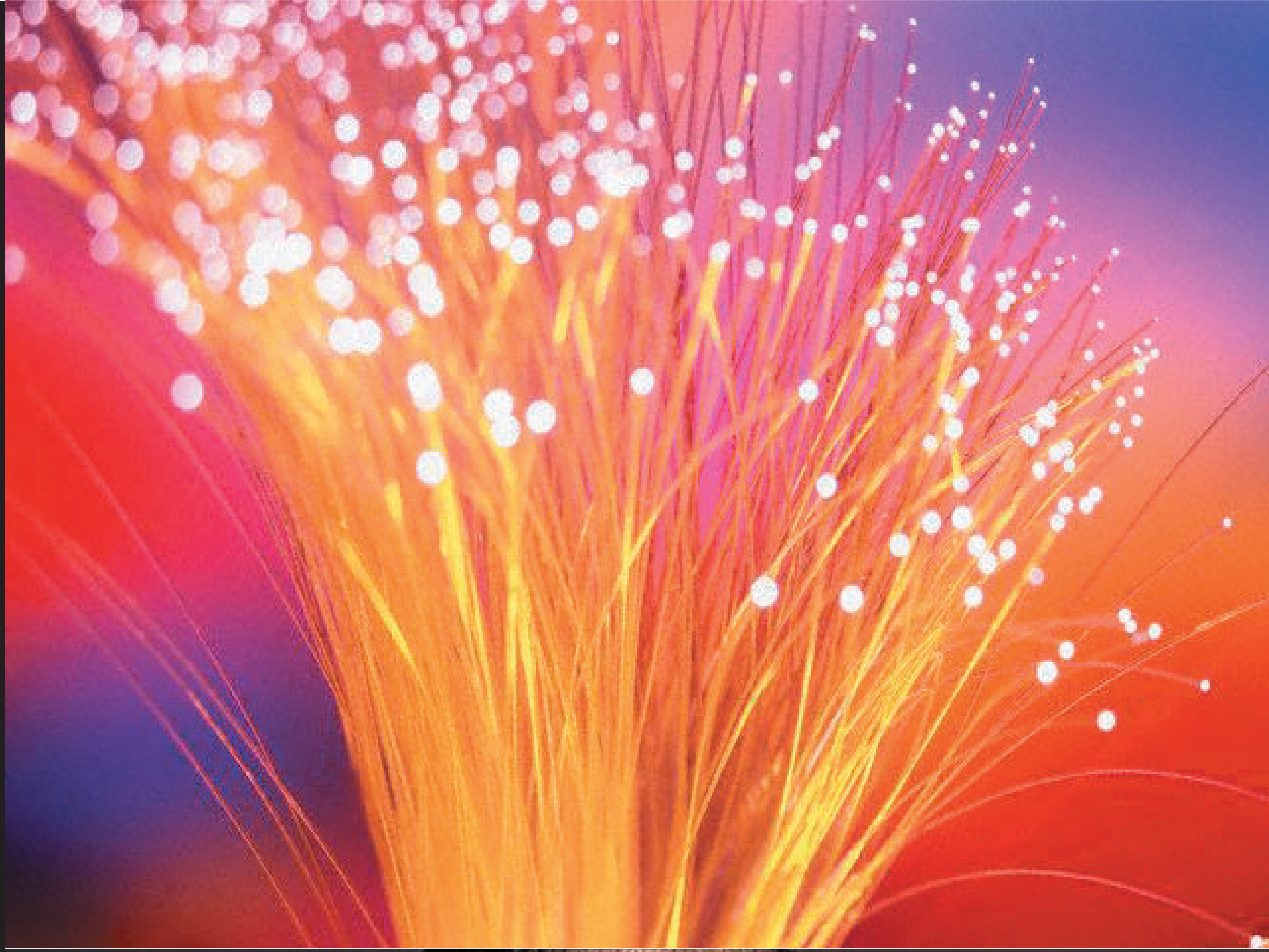




Optical fiber:

a ‘hose’ for light

thickness: about 100 μm



Optical fiber:

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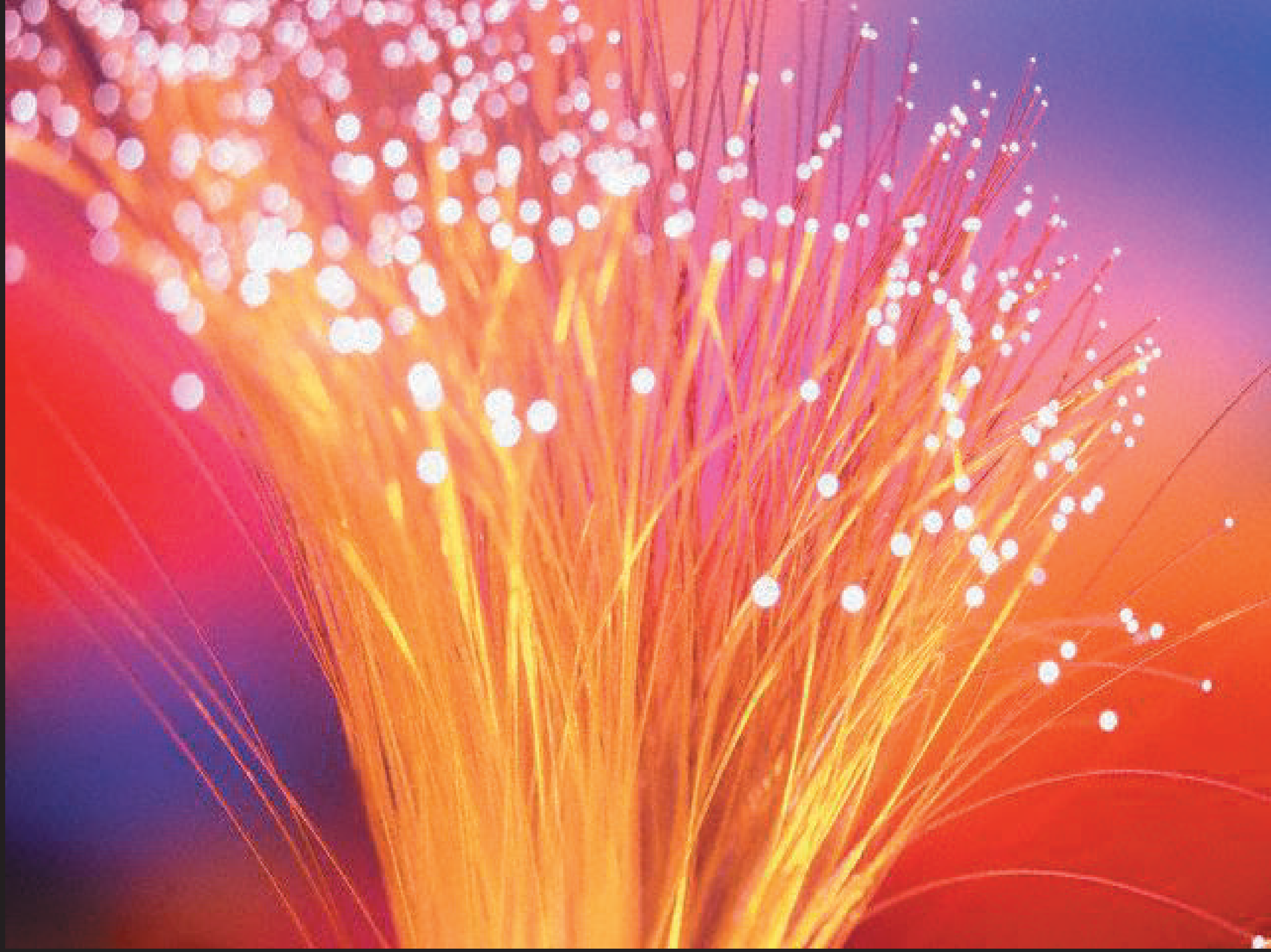
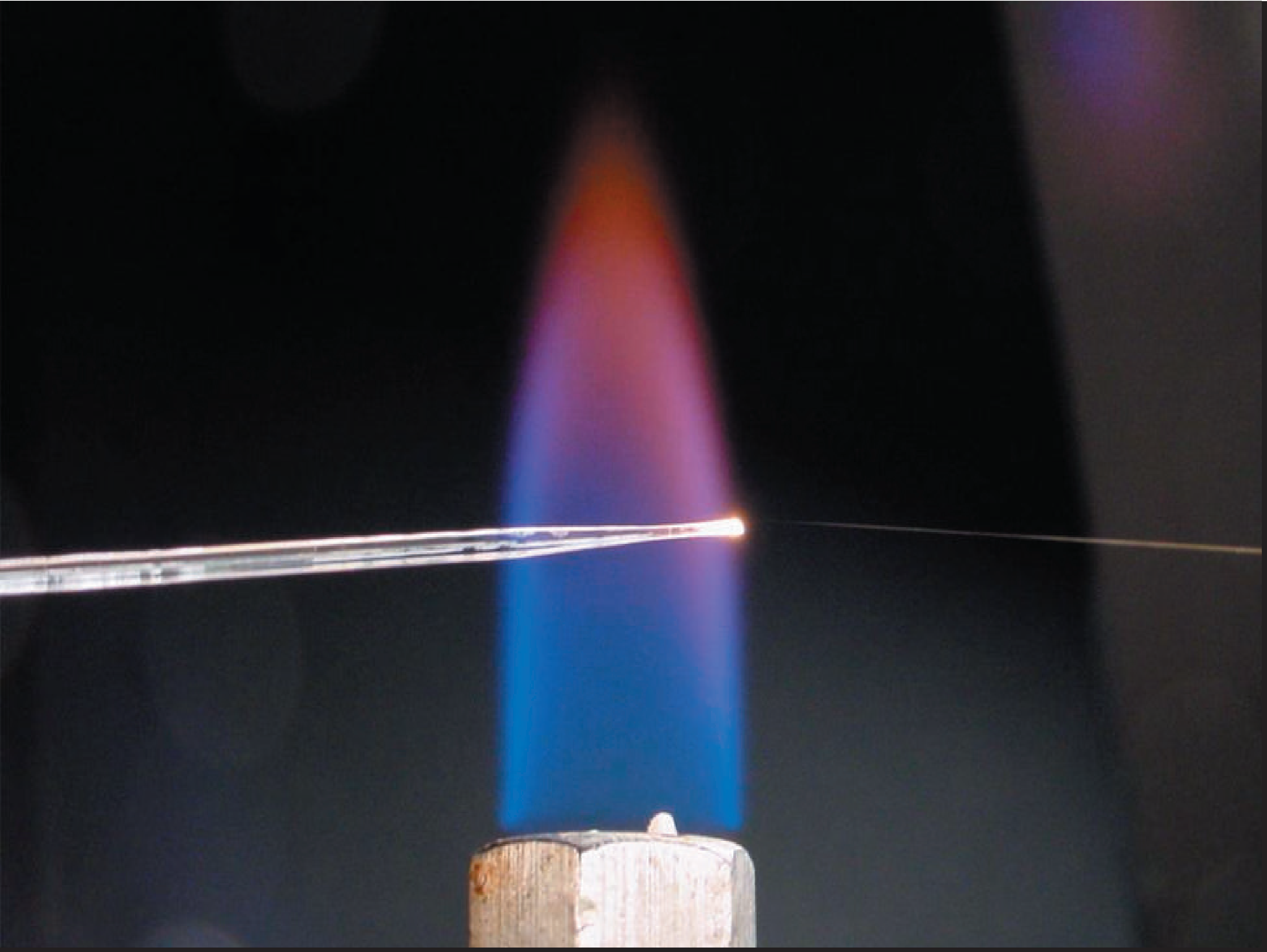
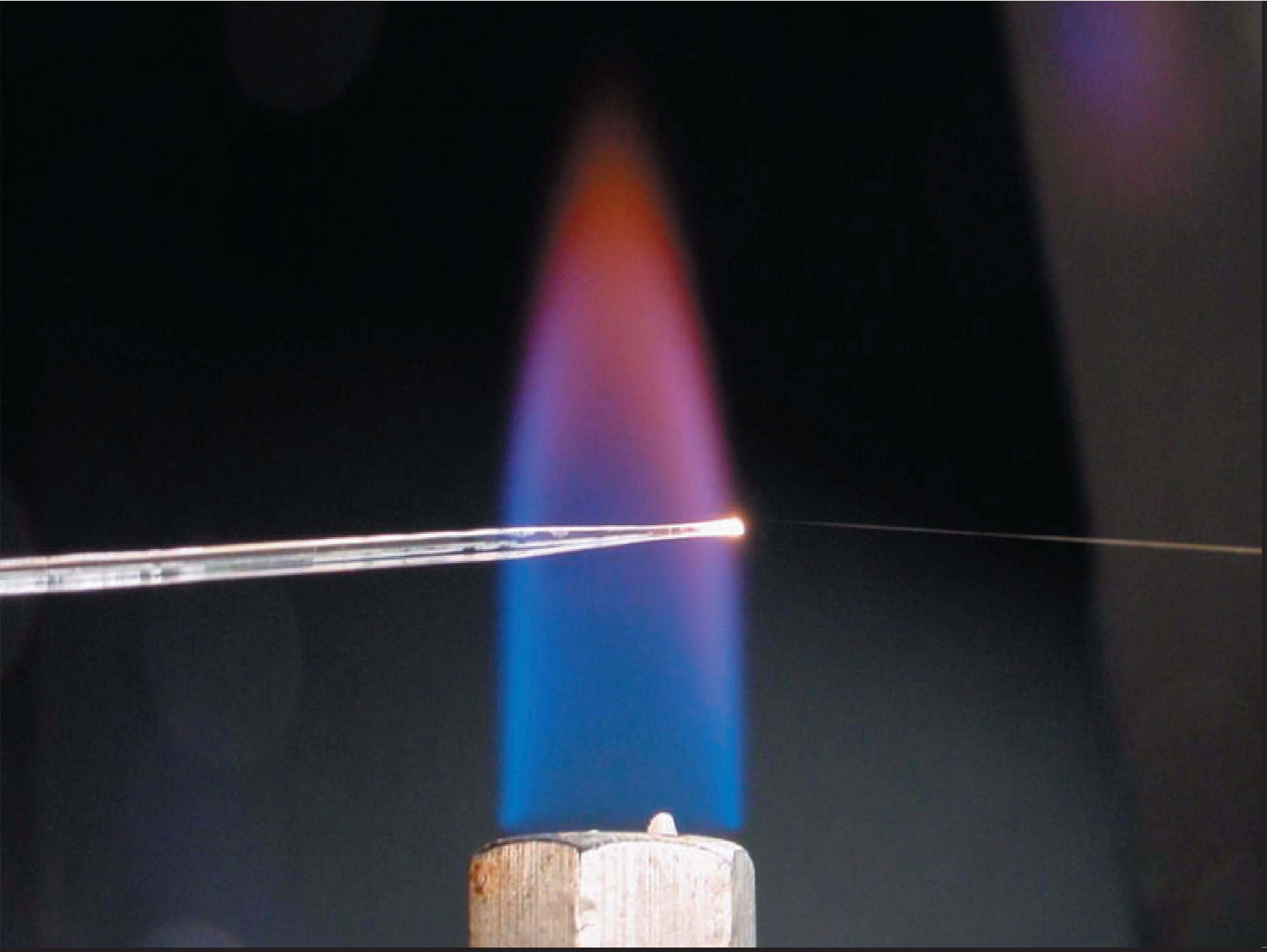


too big for optical chips

thickness: about 100 μm

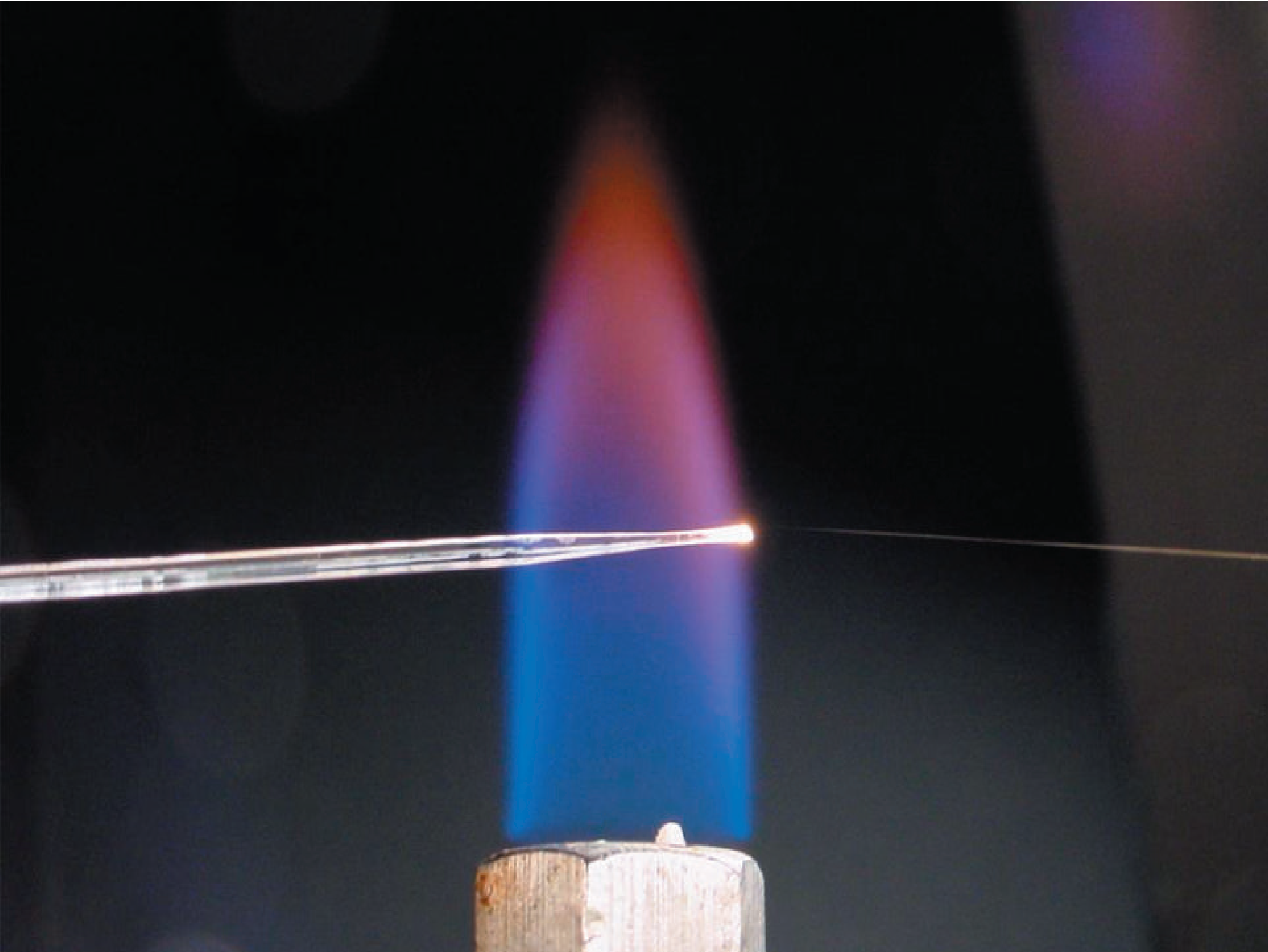
no tight bending of light





fabricating nanowires:

as thin as 20 nm!



fabricating nanowires:

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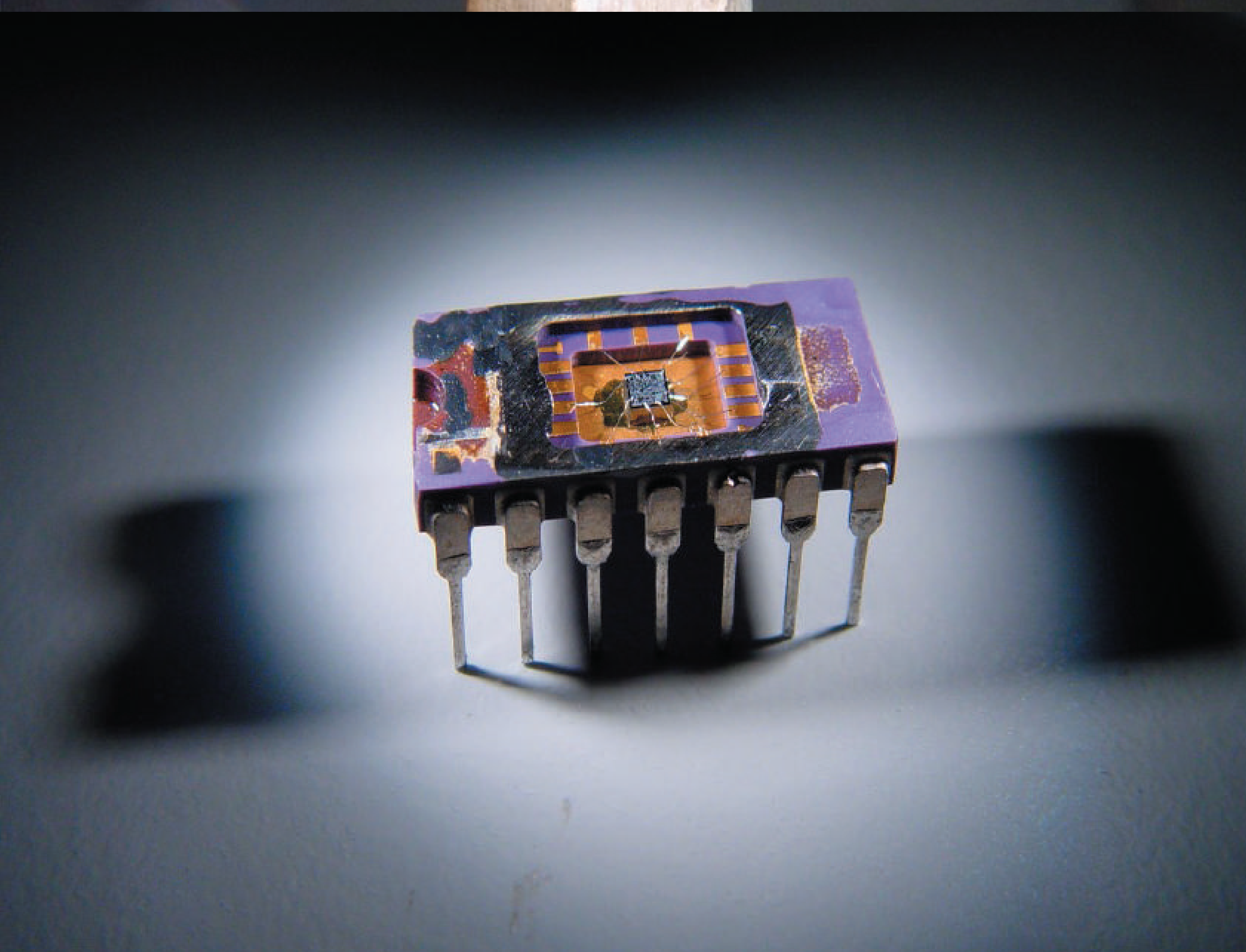
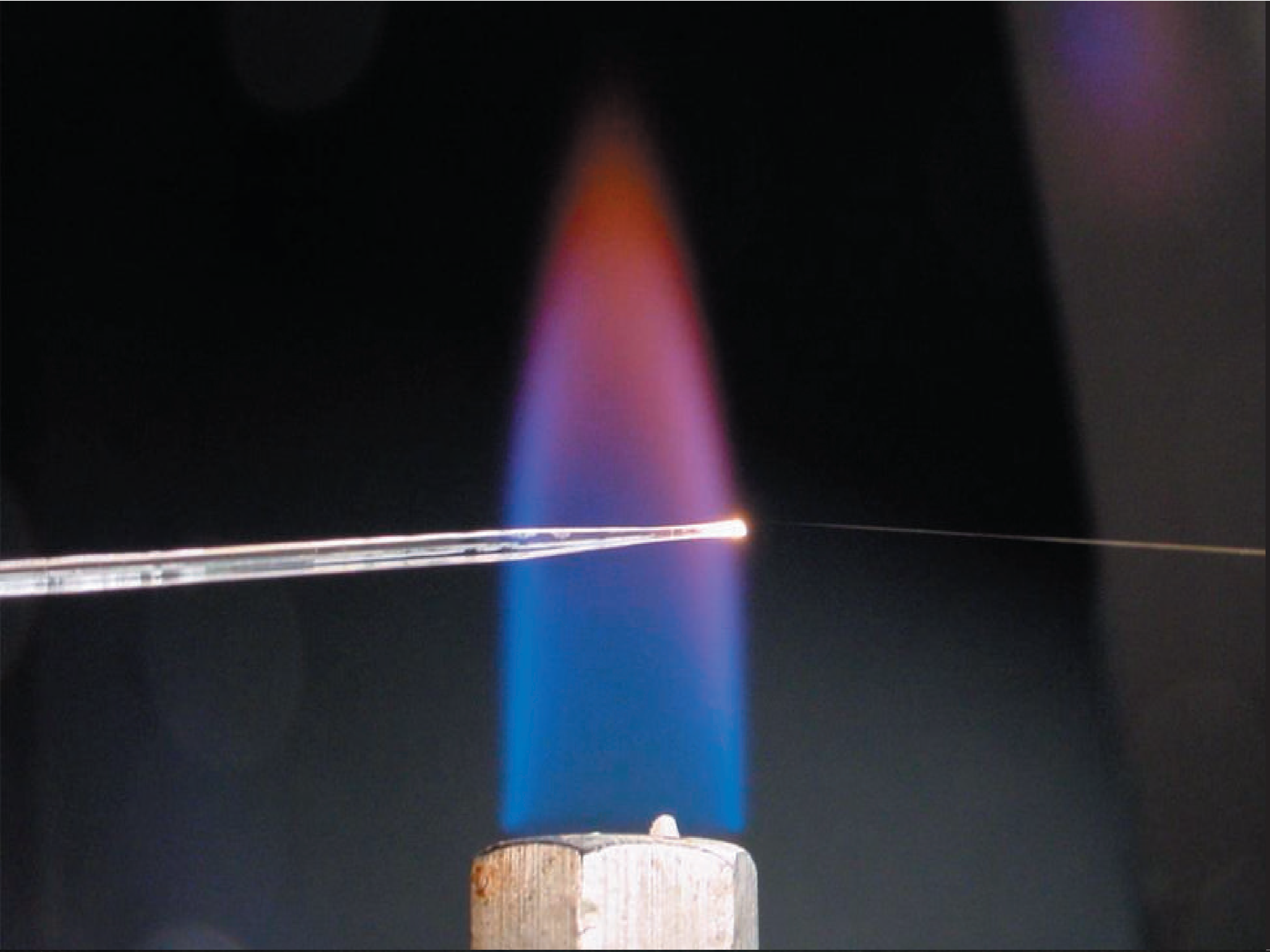
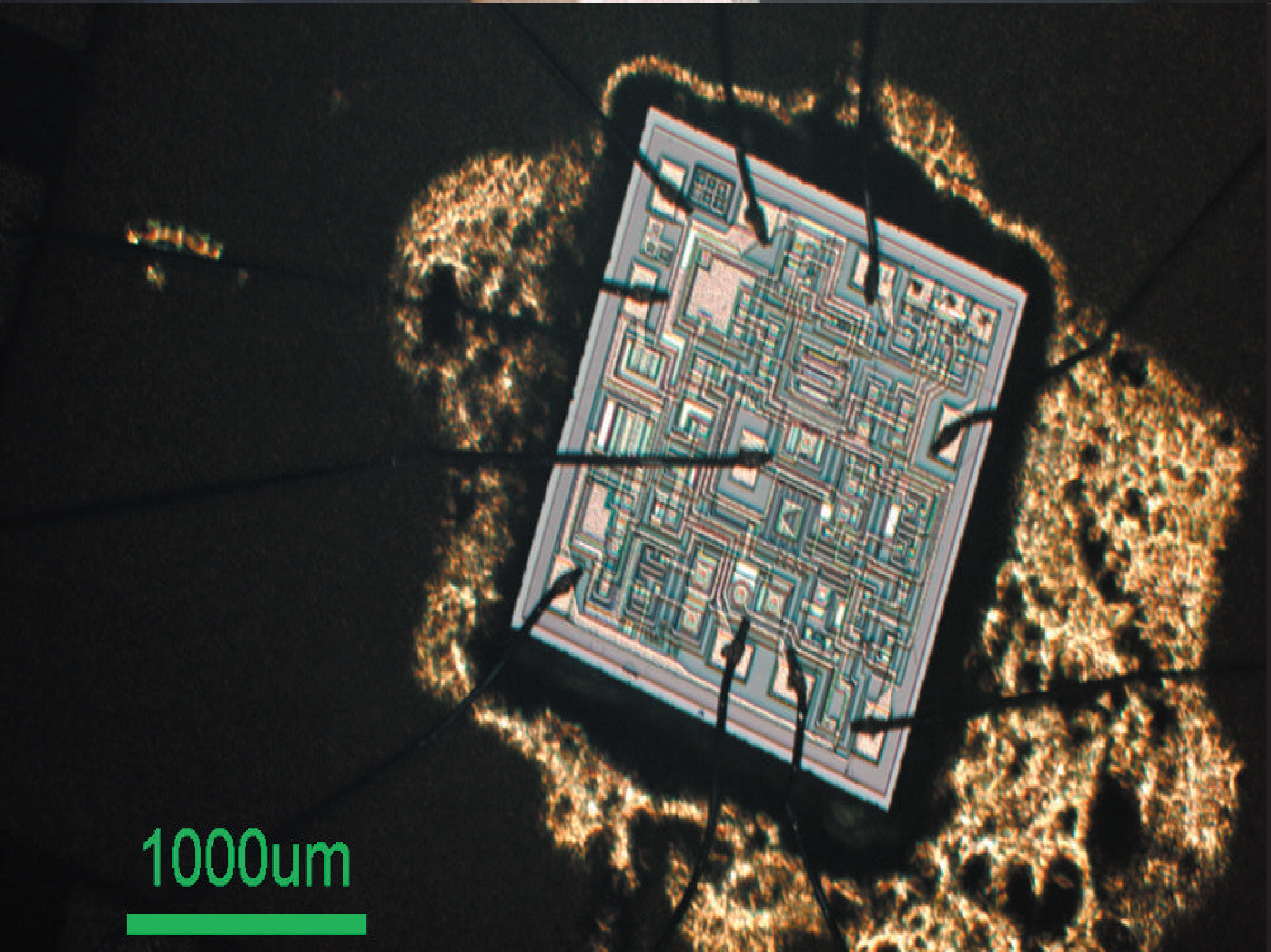
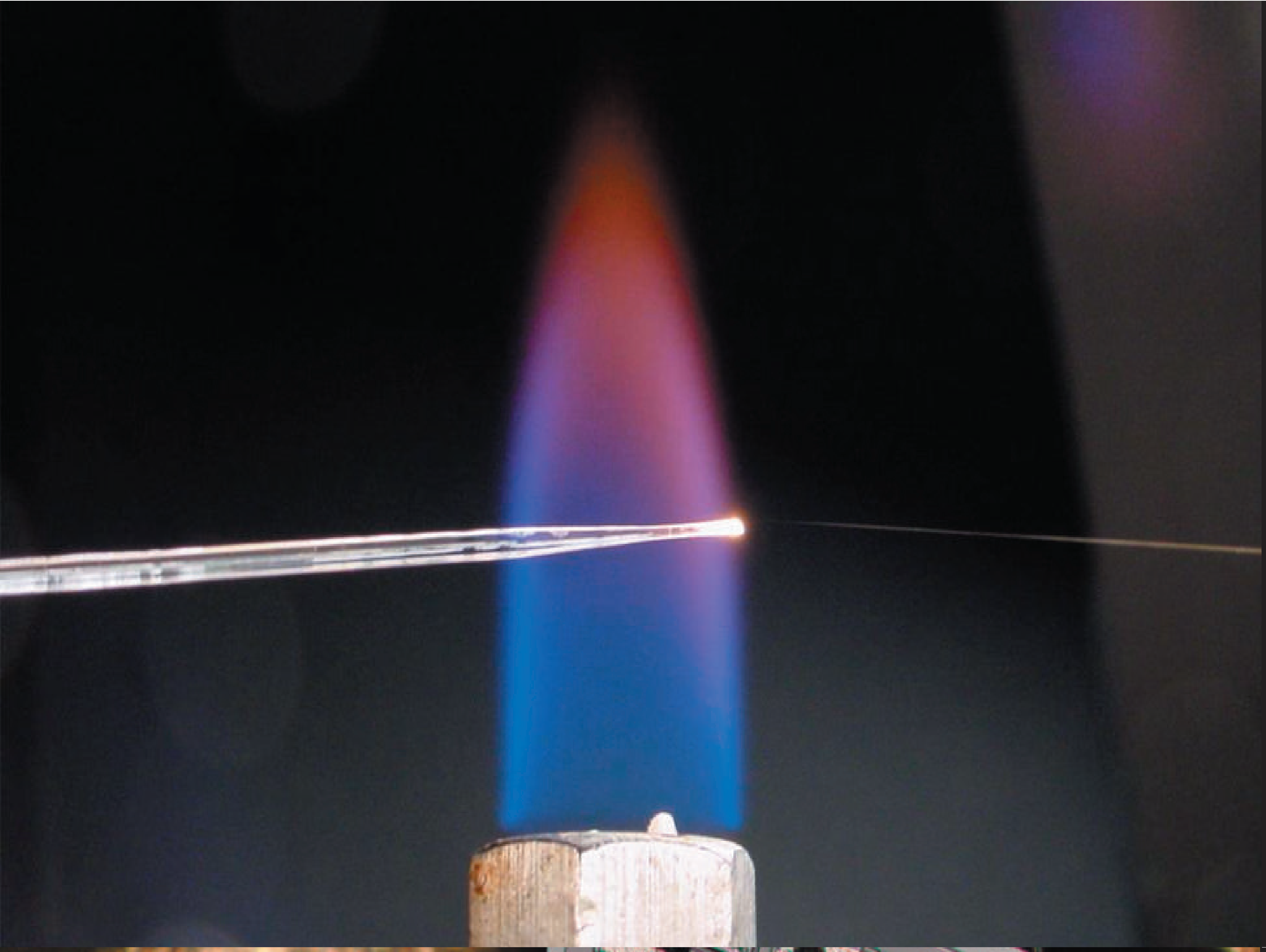




fabricating nanowires:

as thin as 20 nm!





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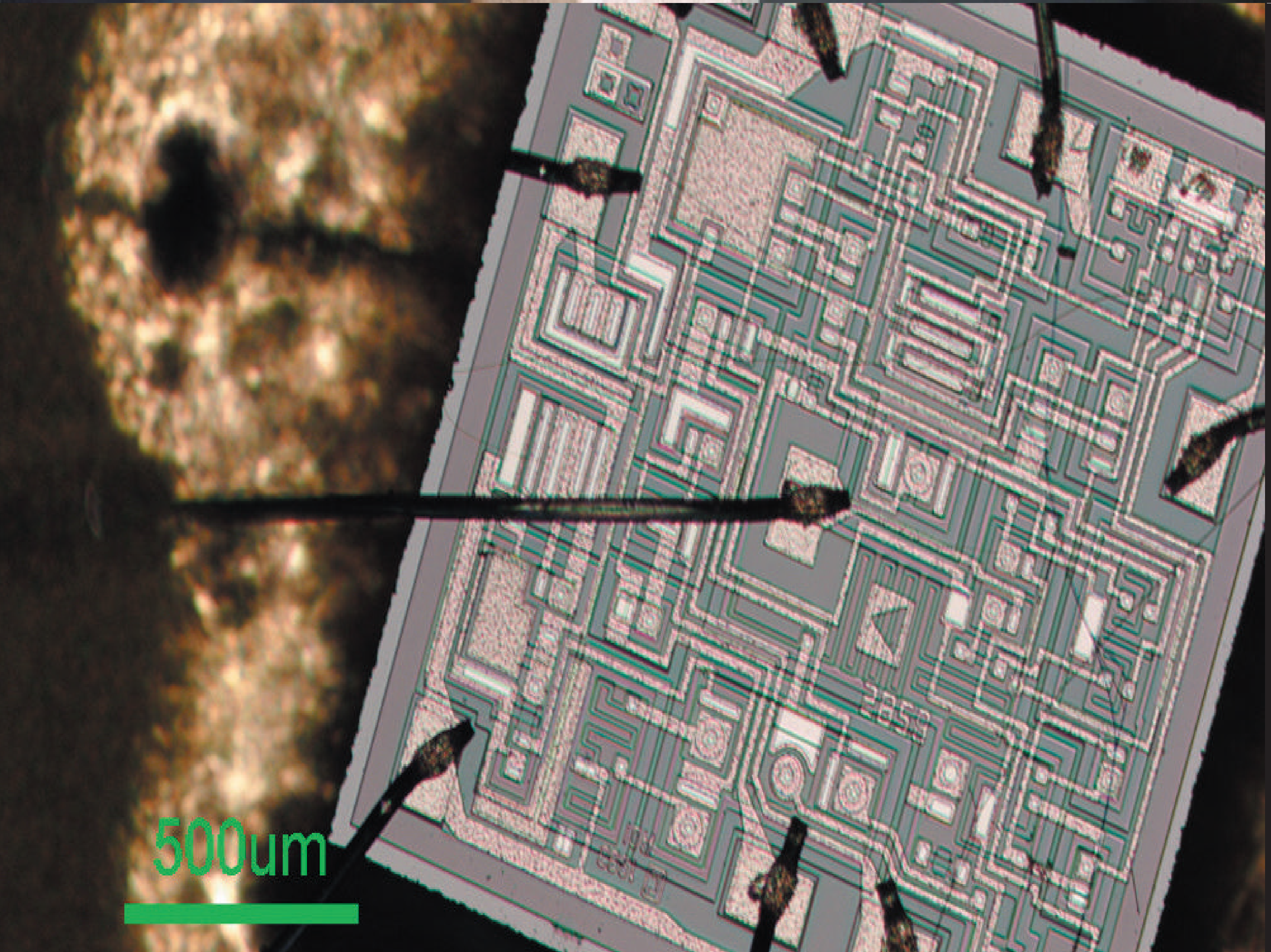

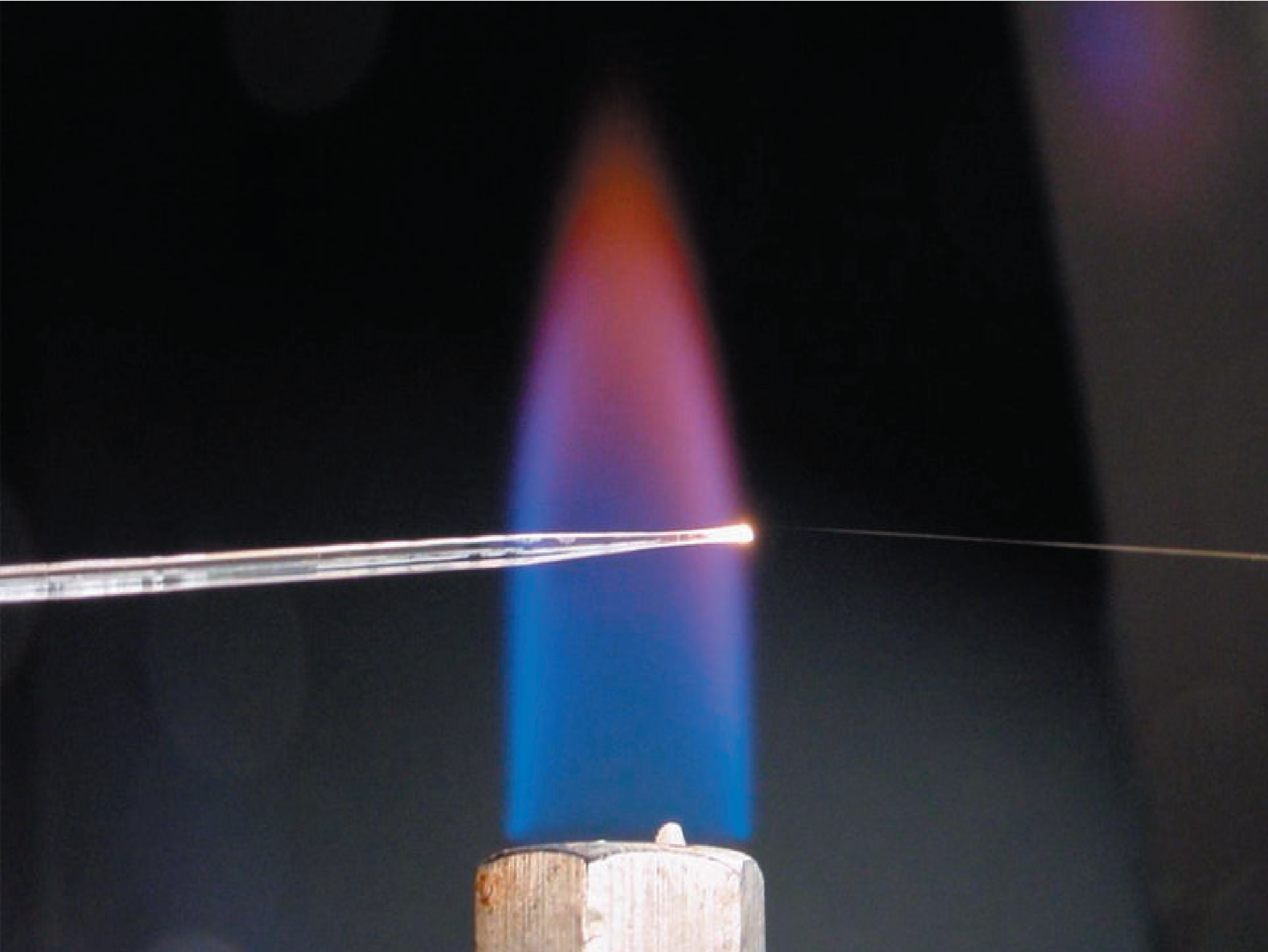

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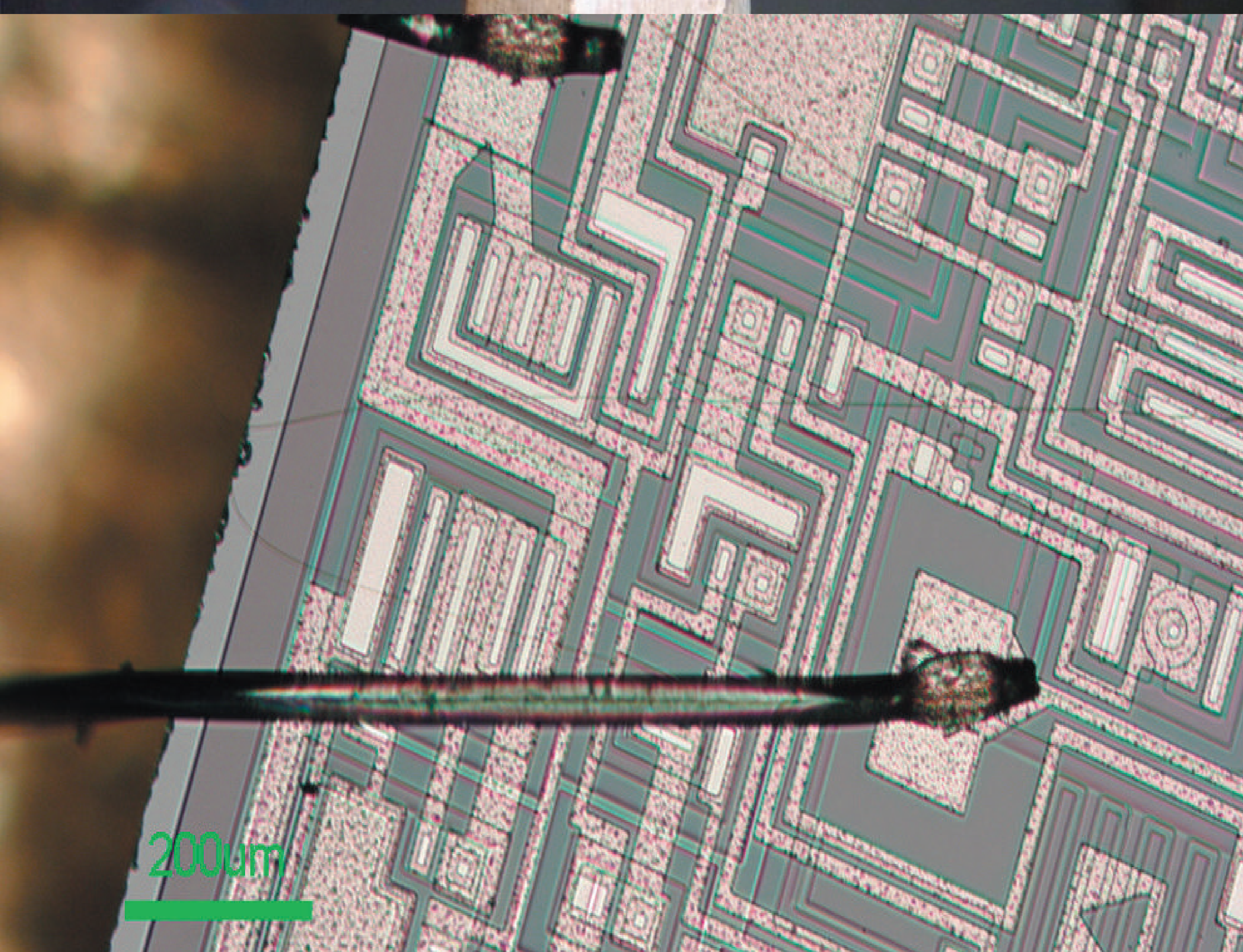

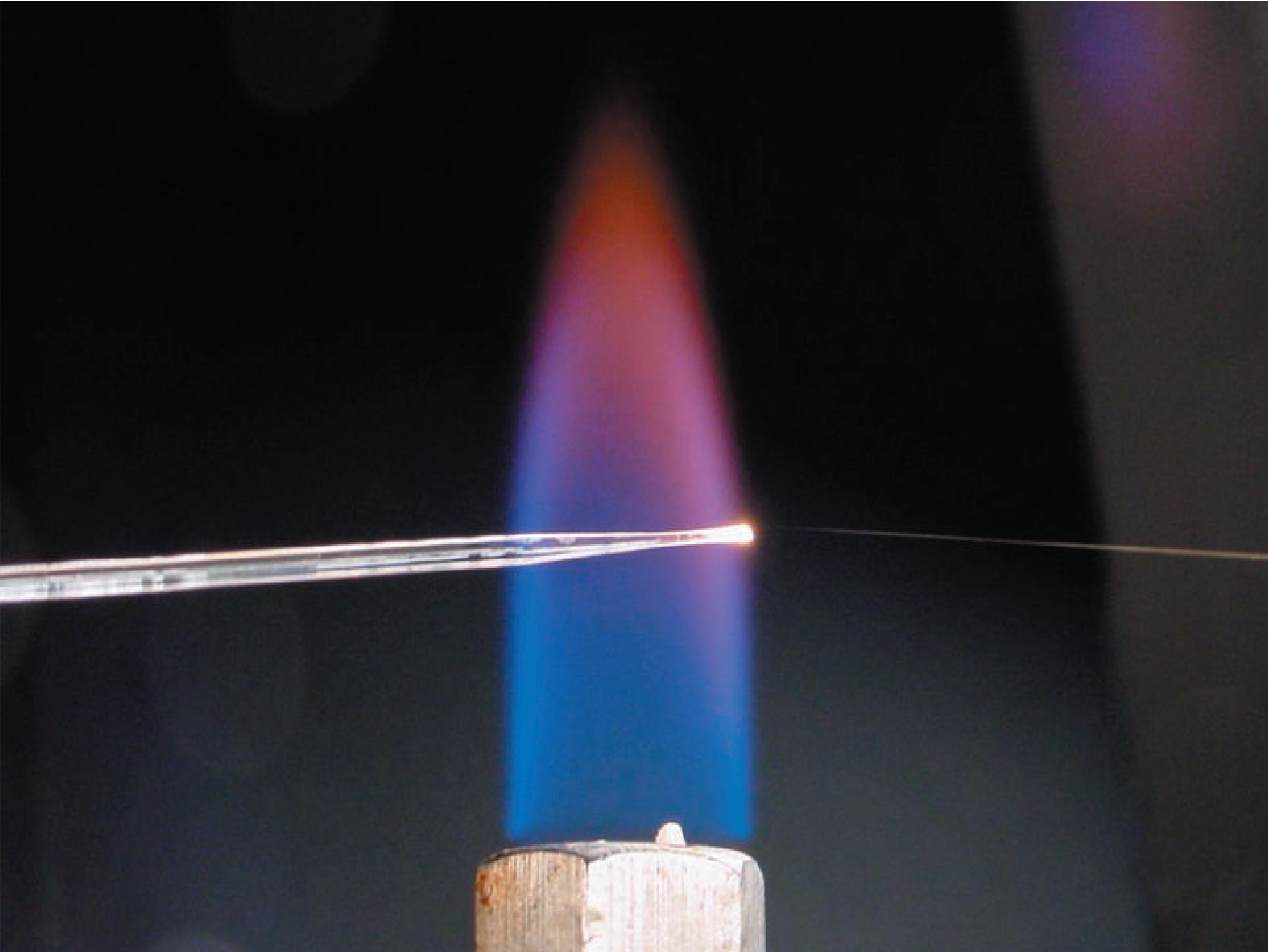

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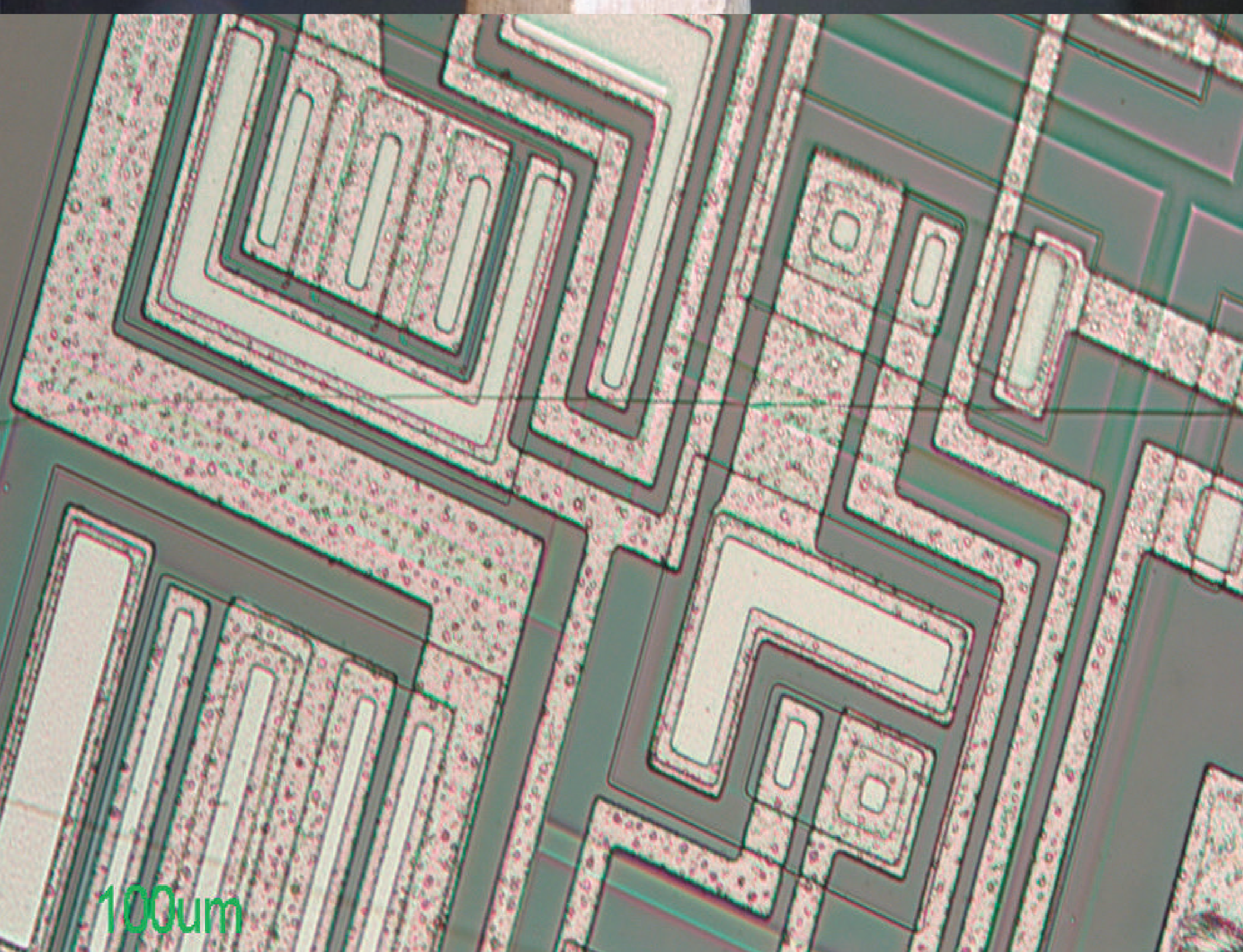

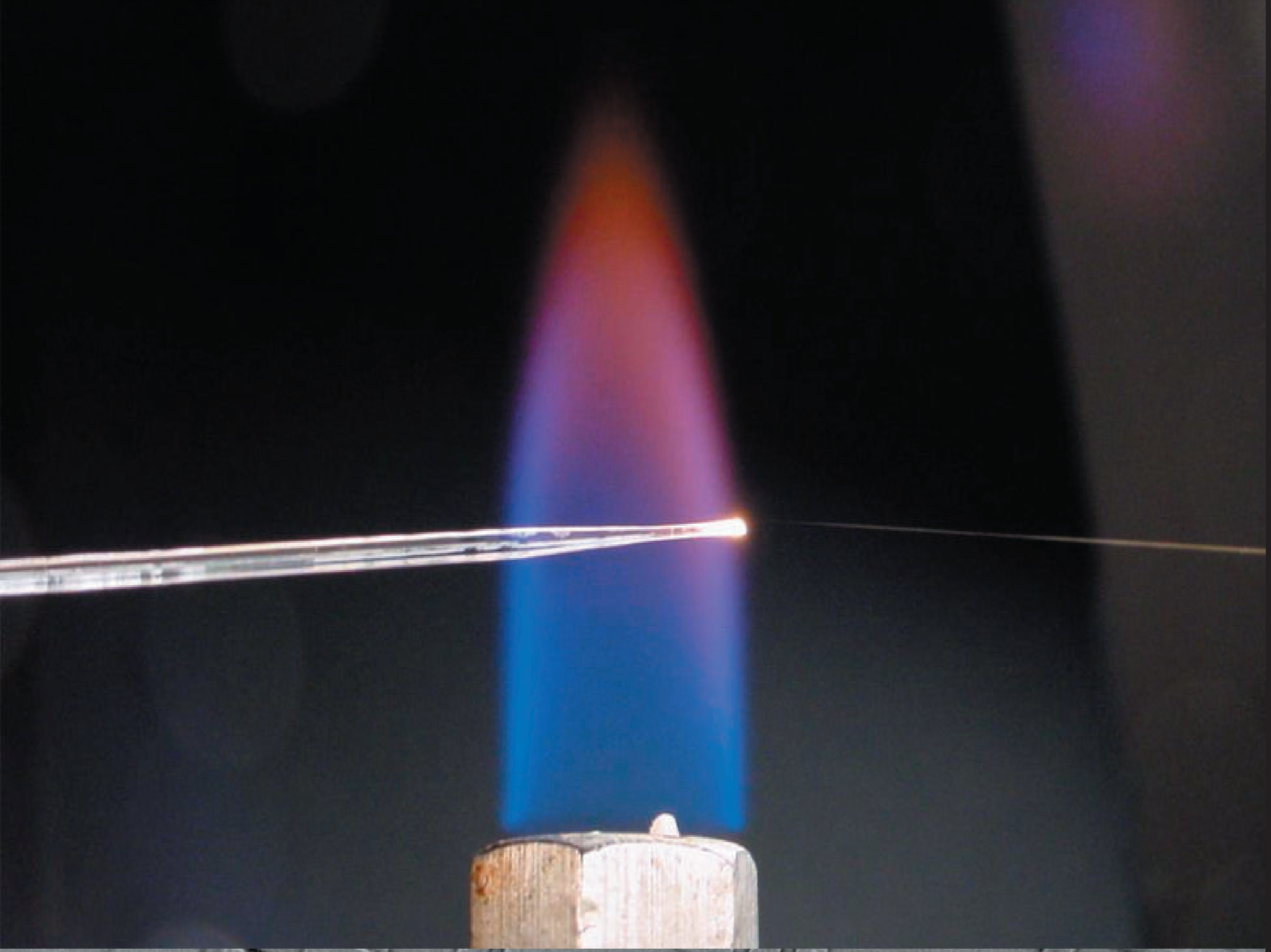
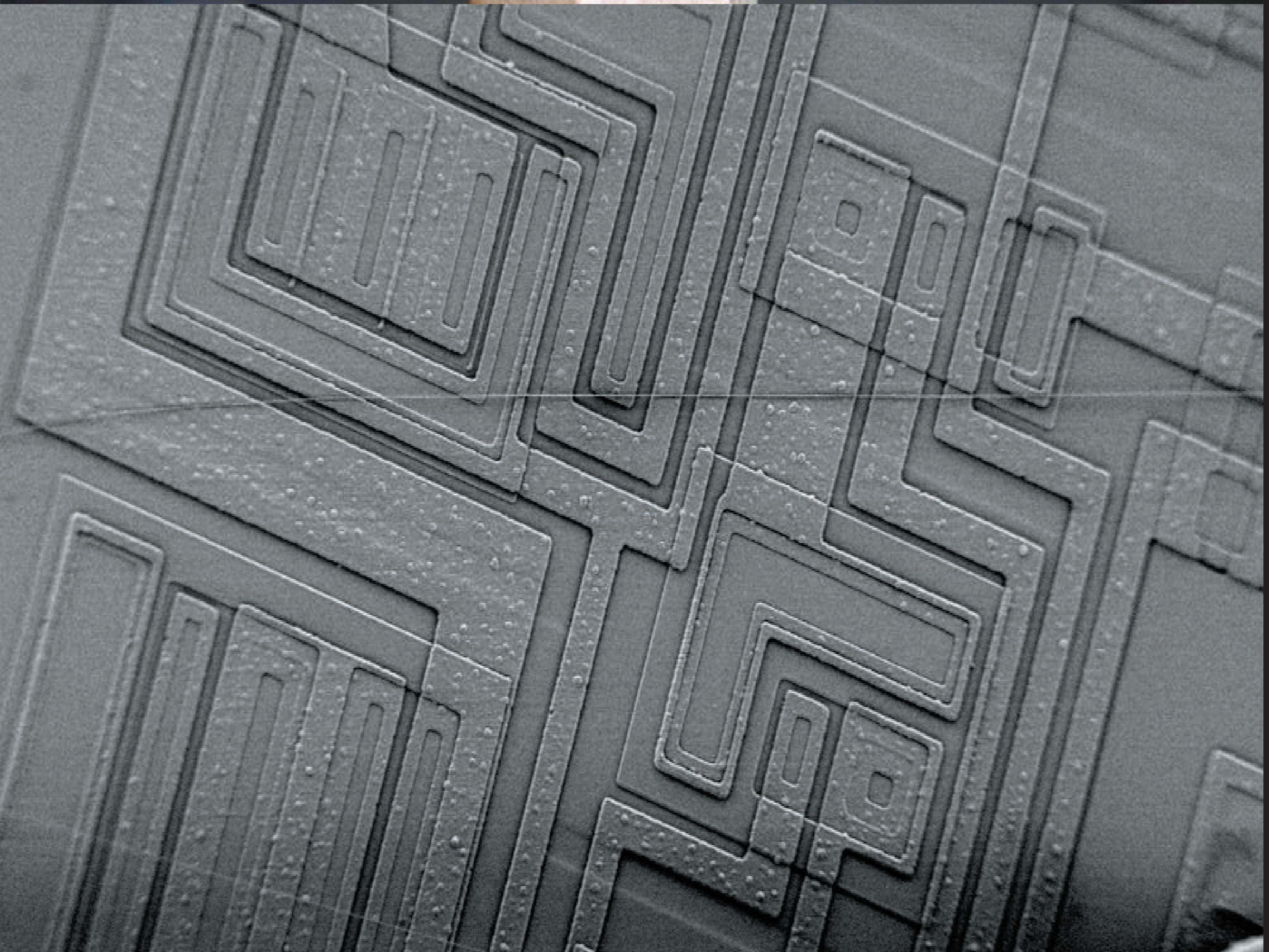

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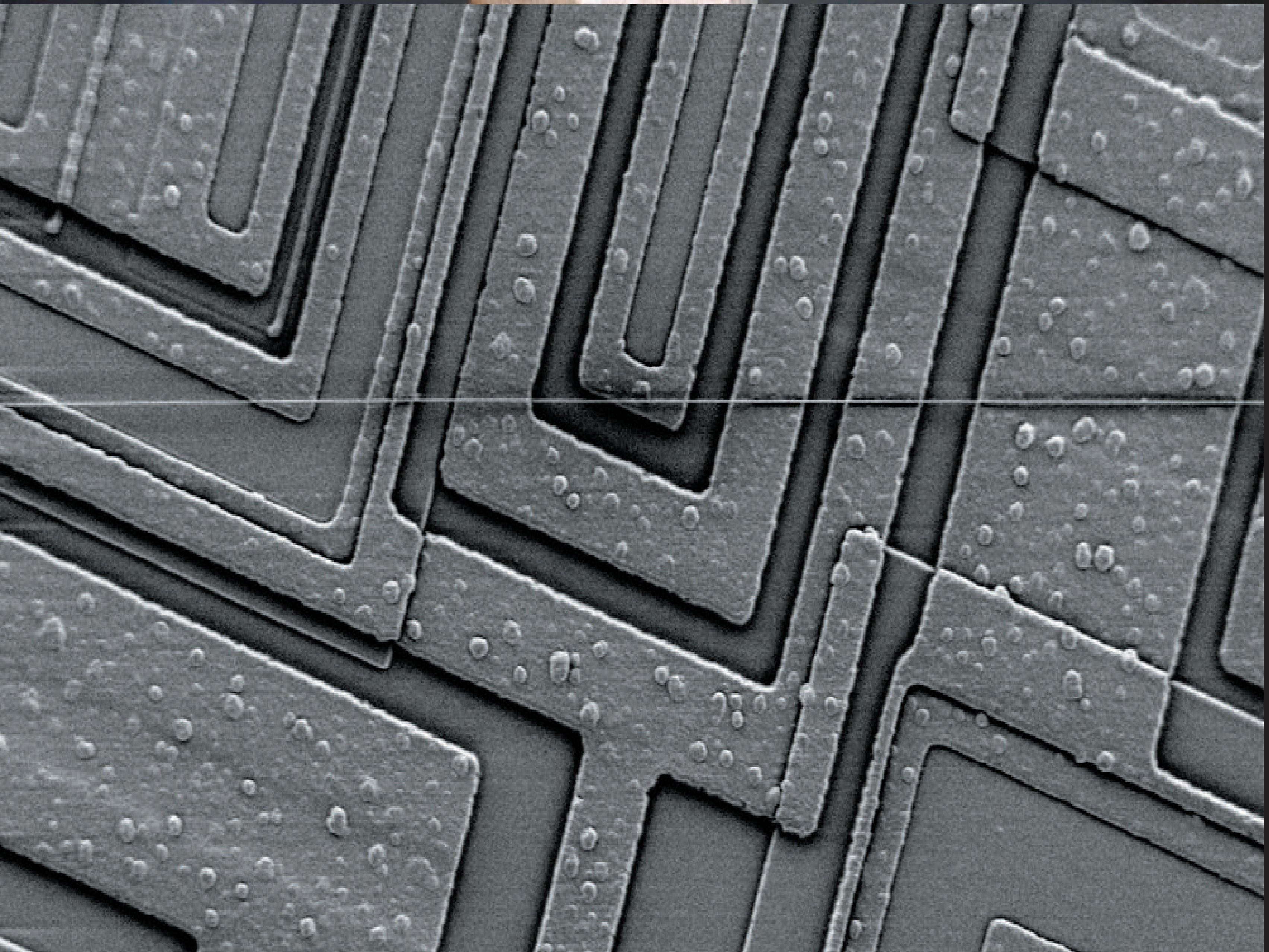

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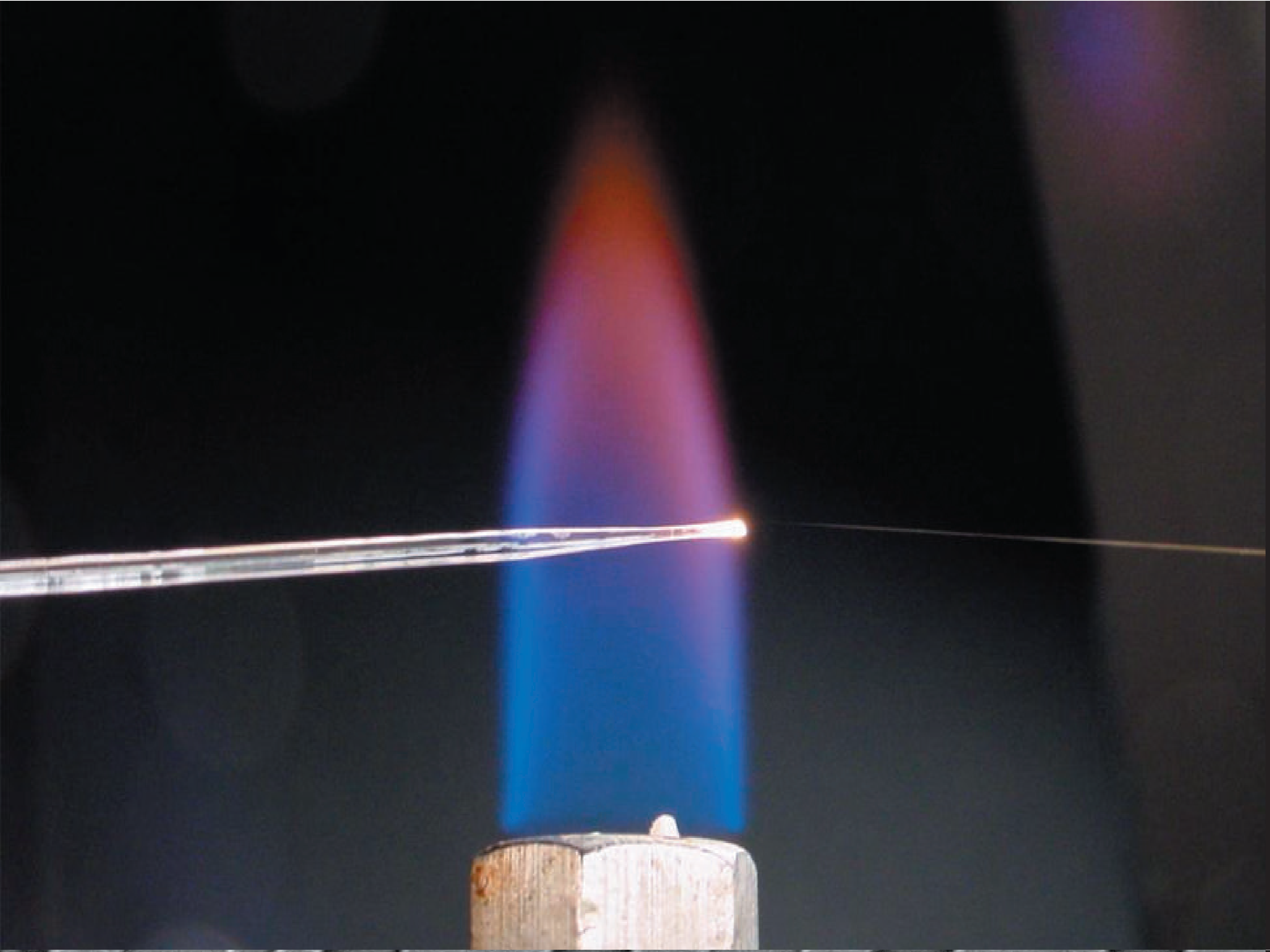

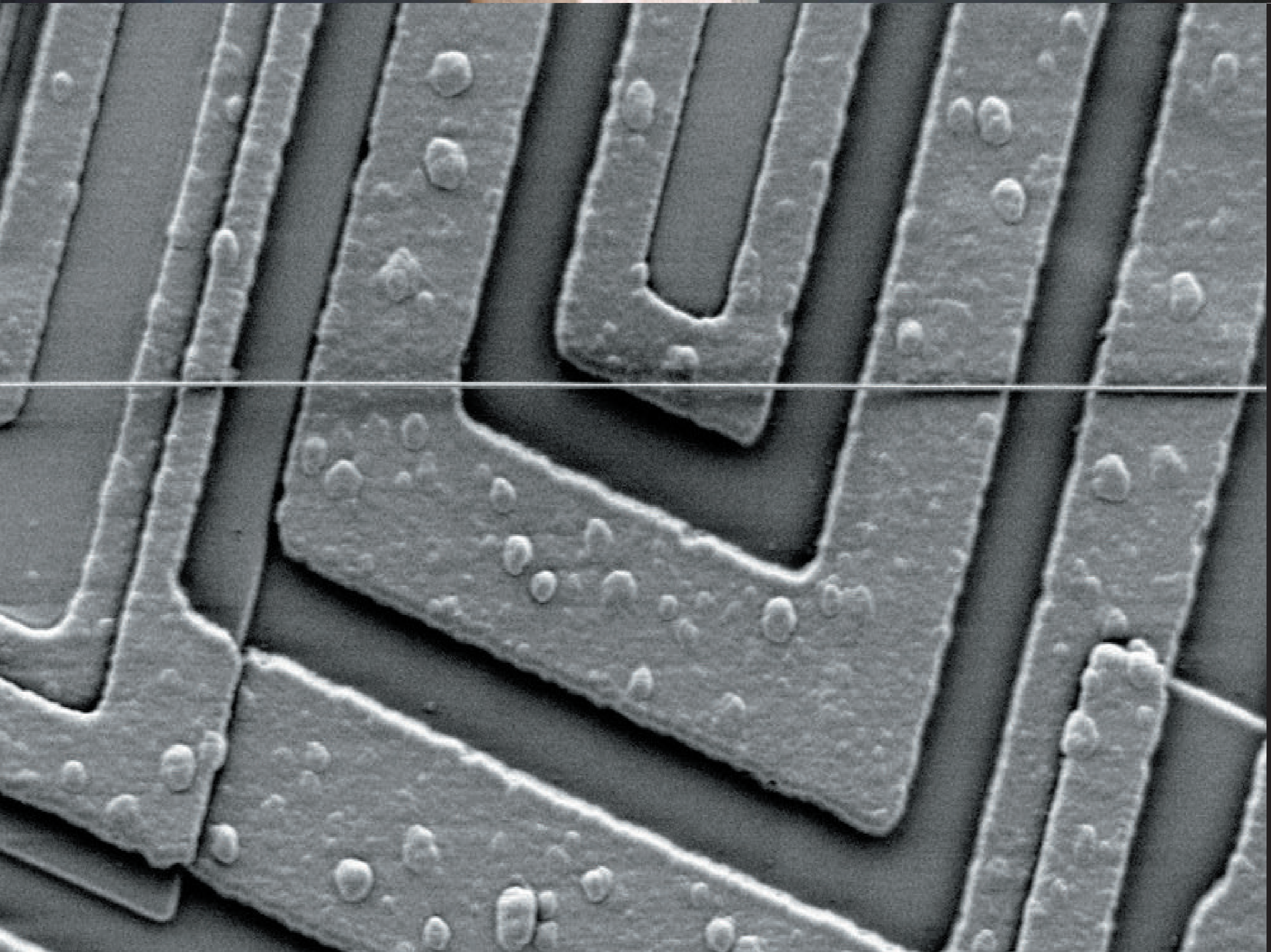

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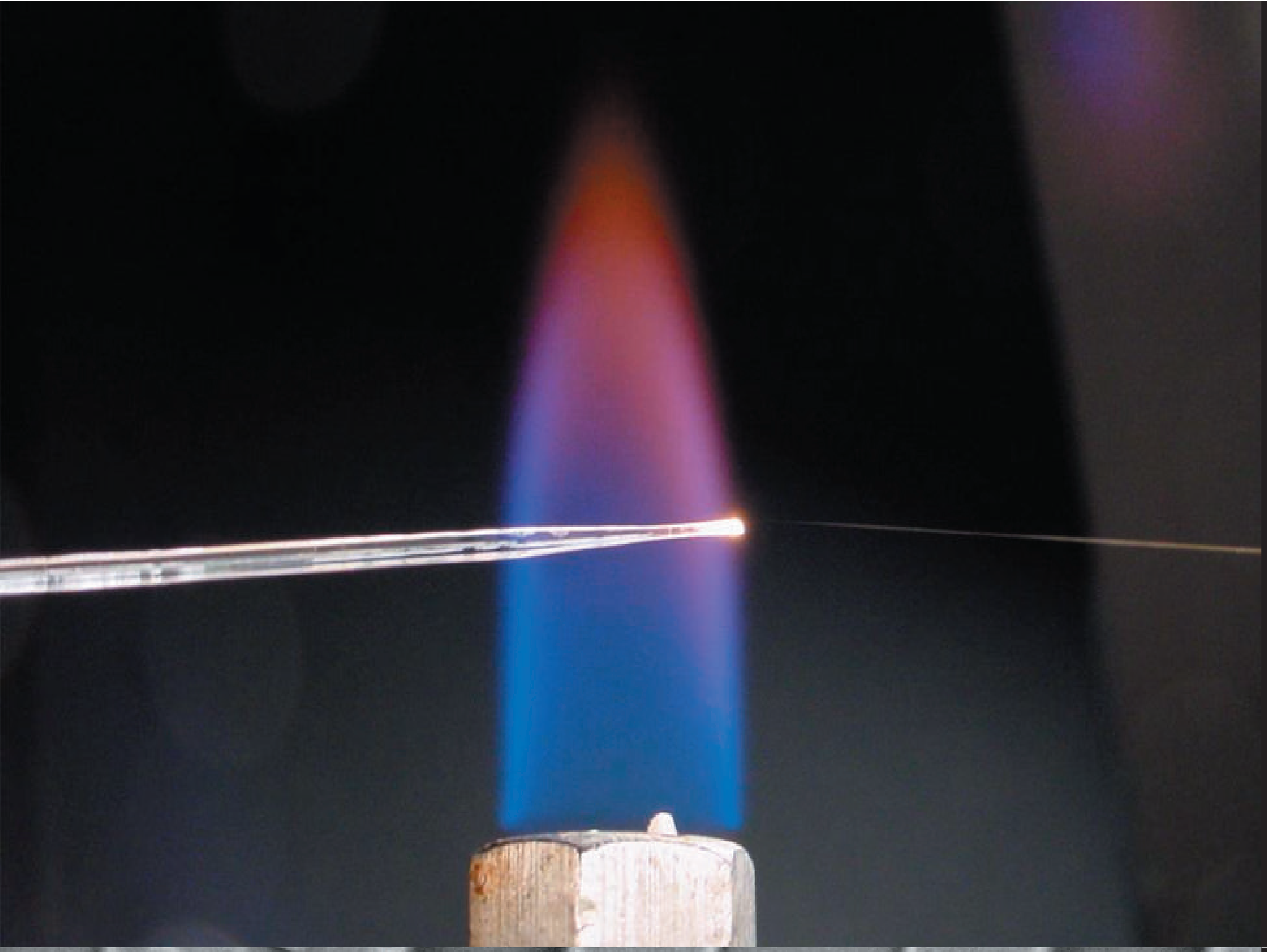

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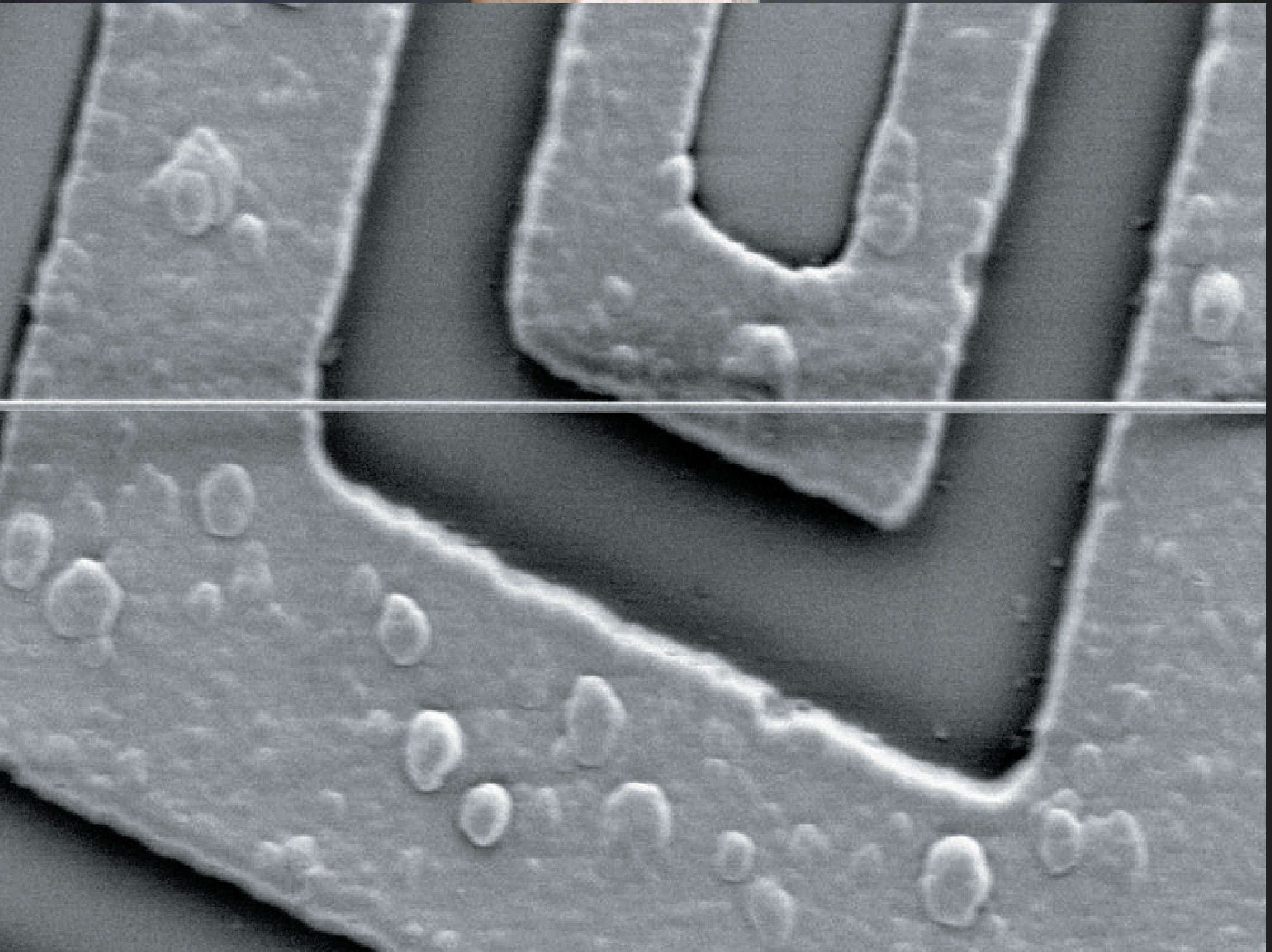

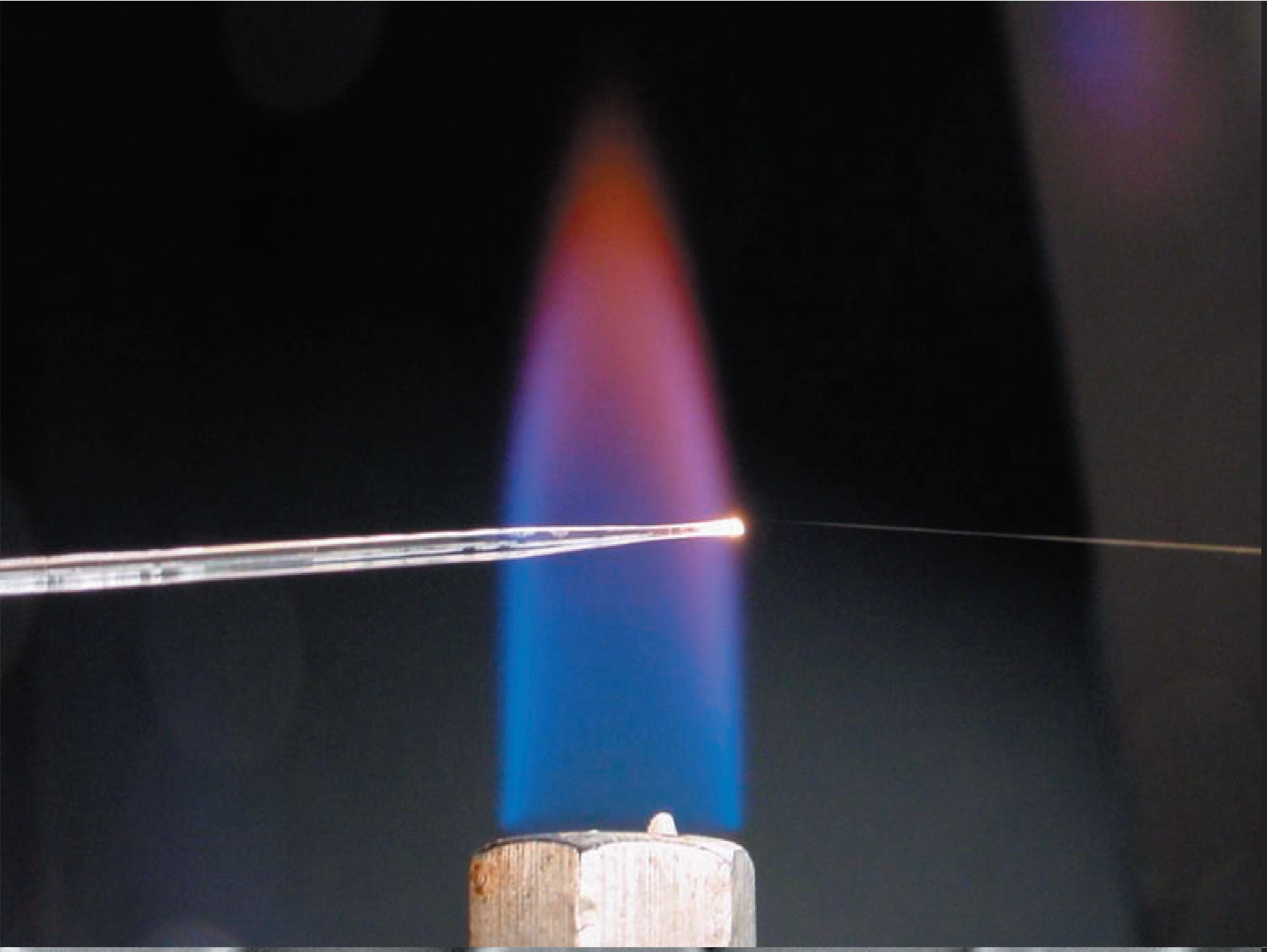

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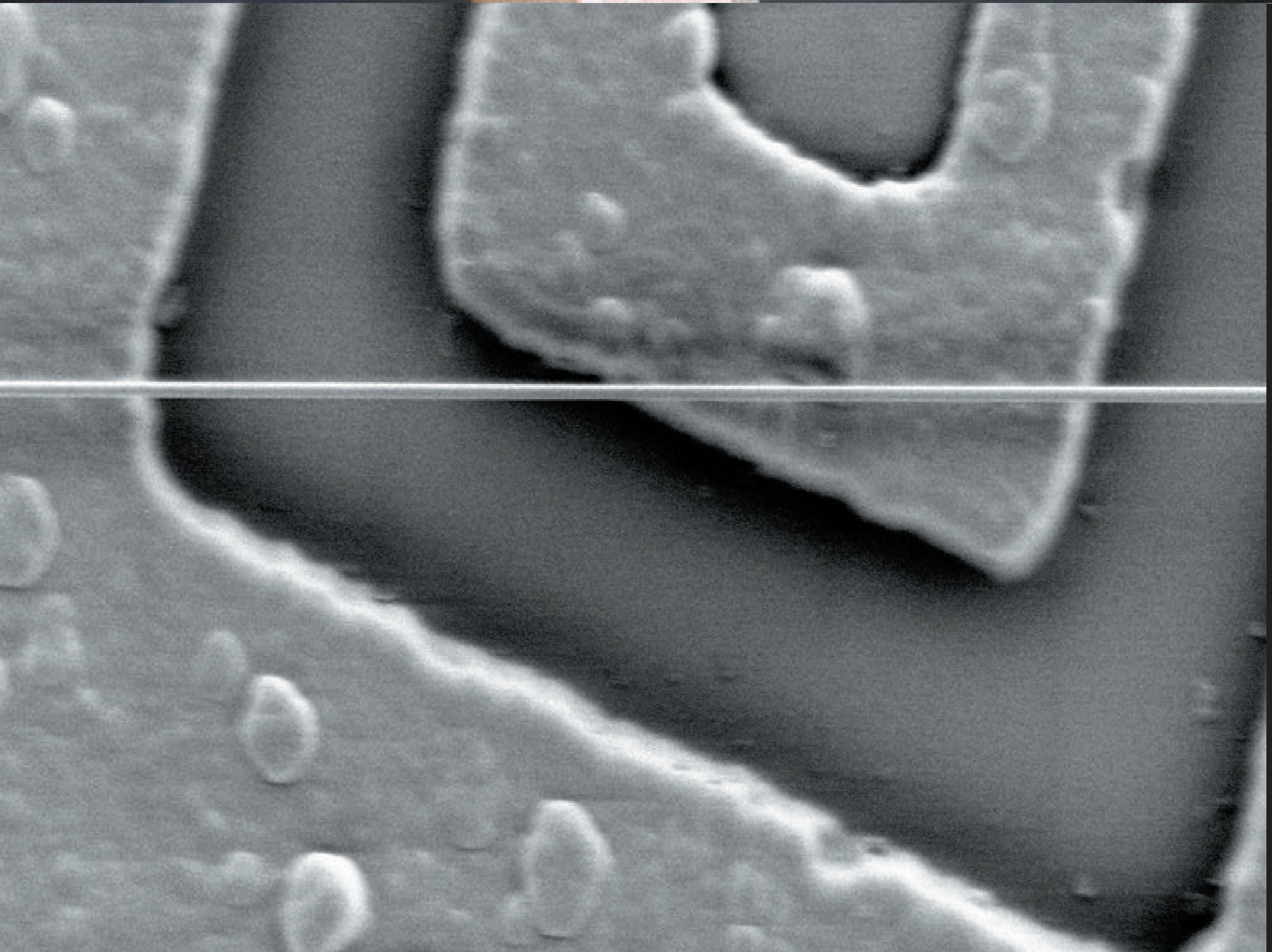

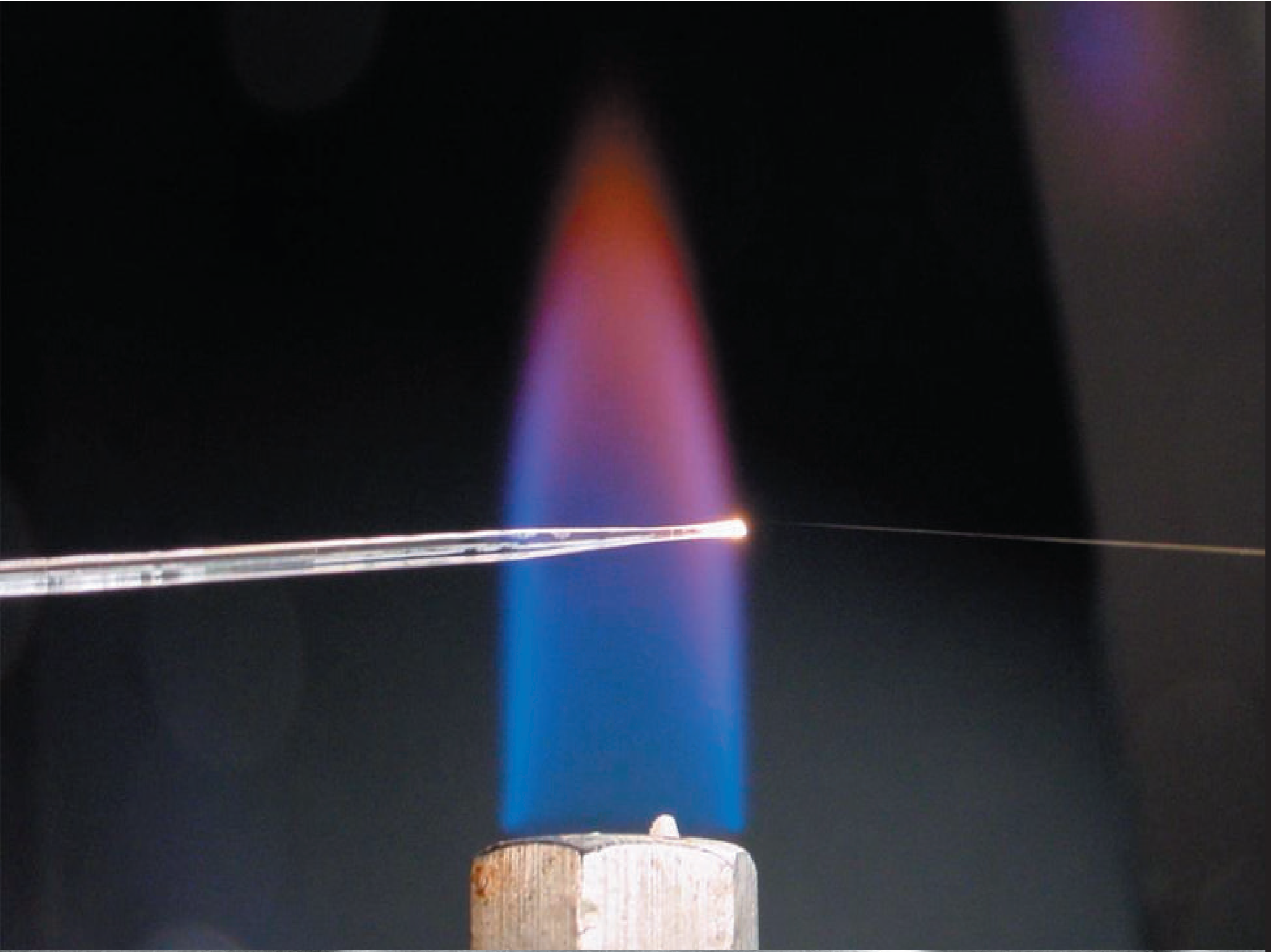

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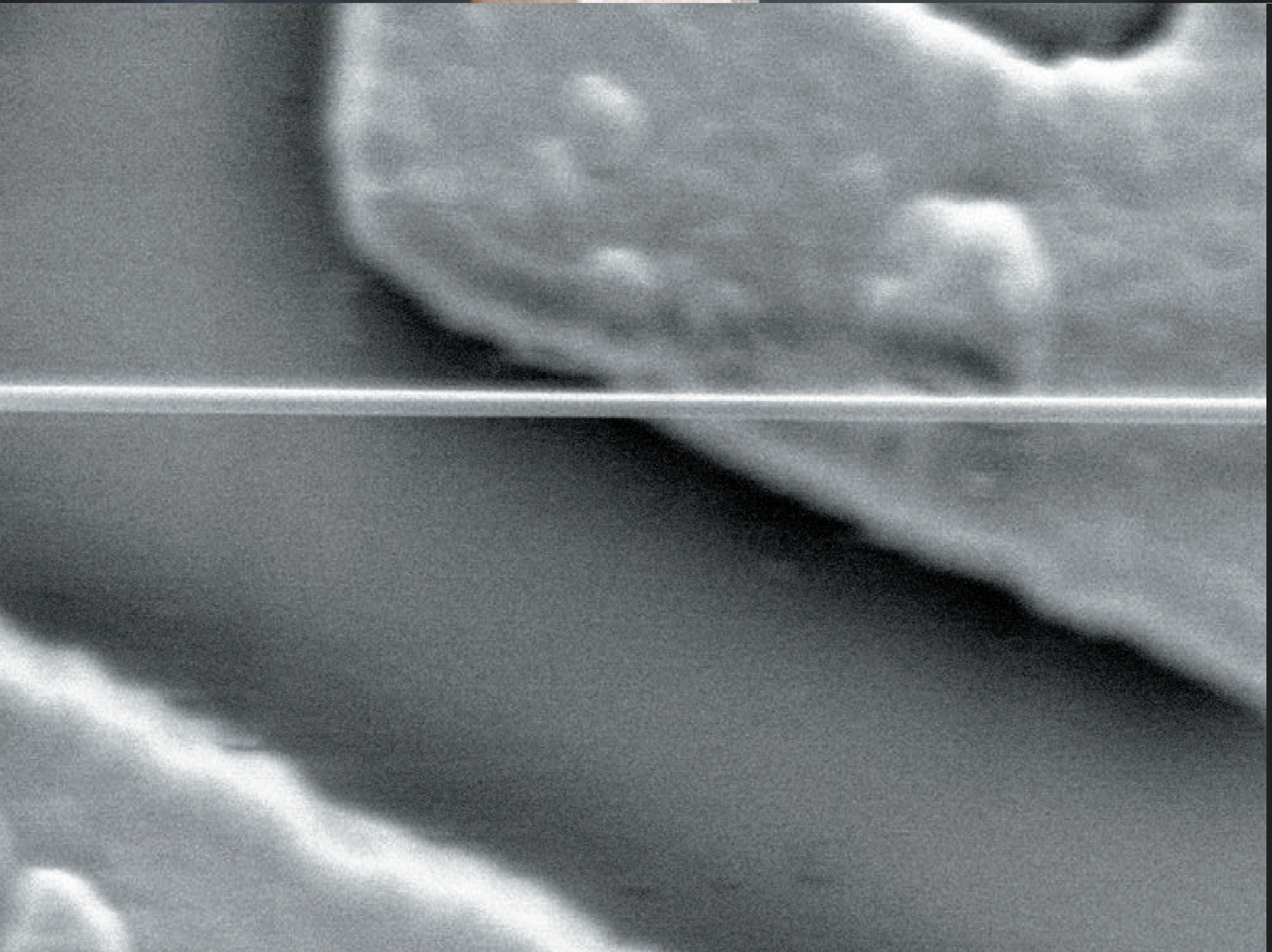

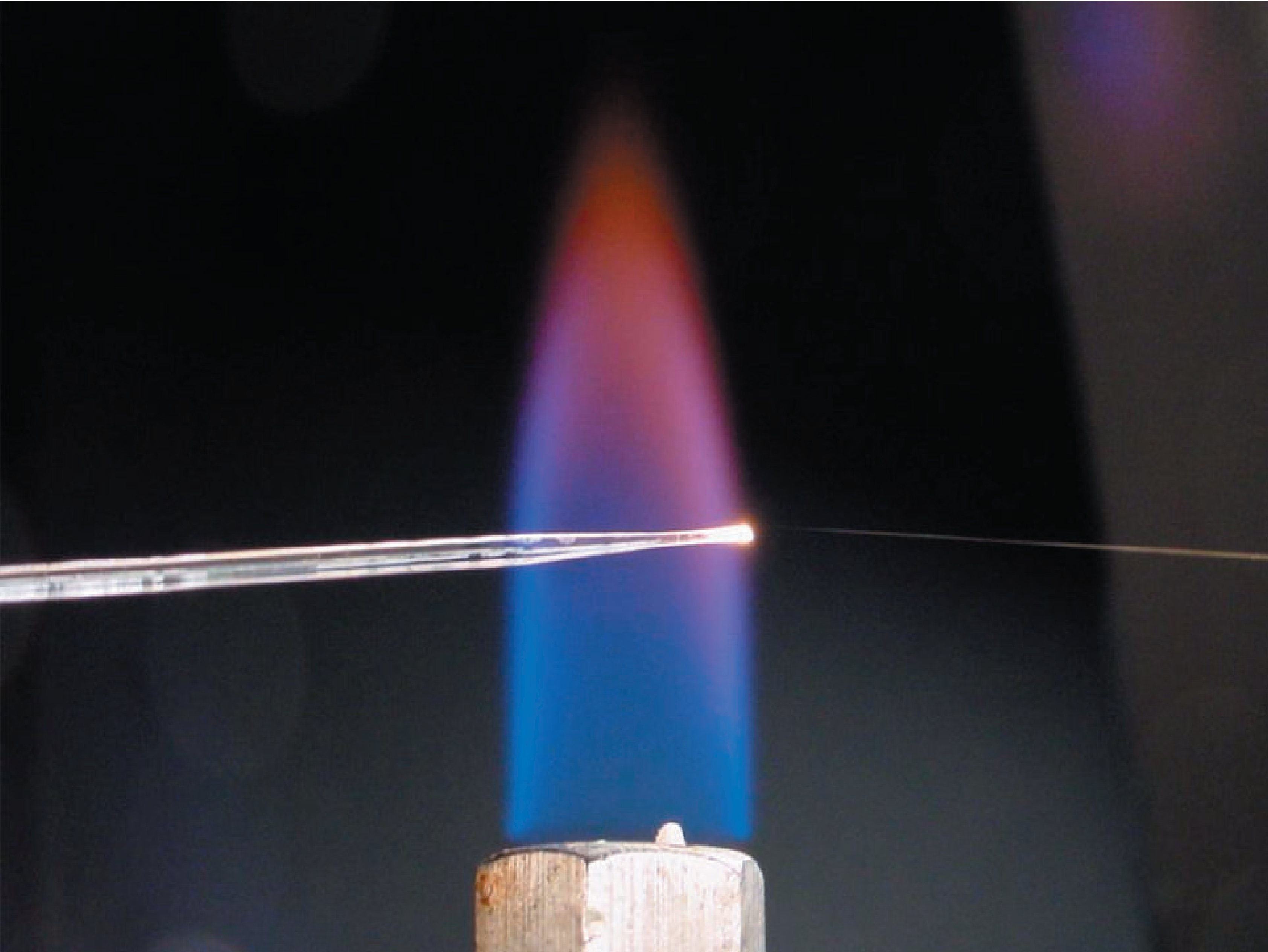

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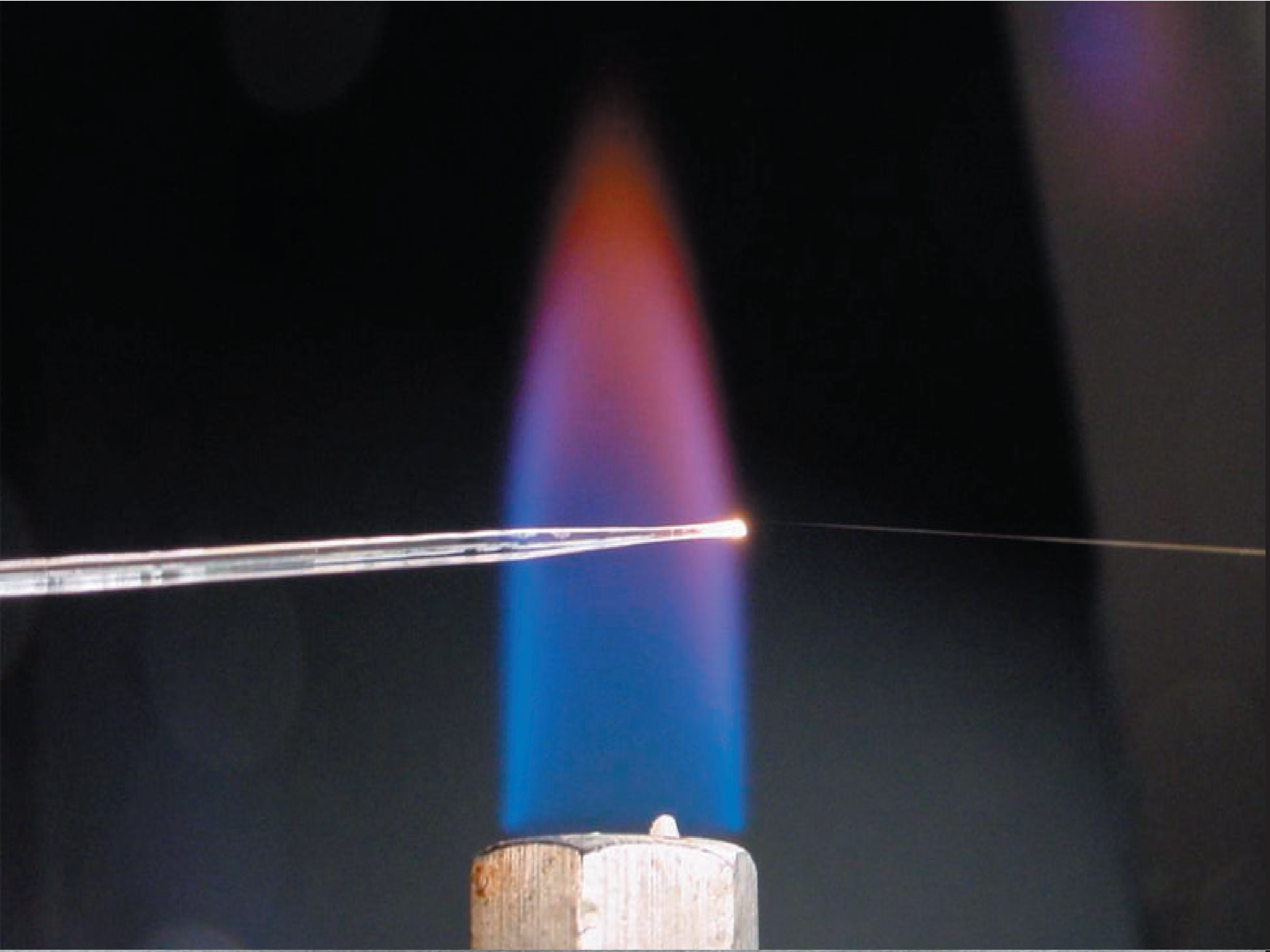

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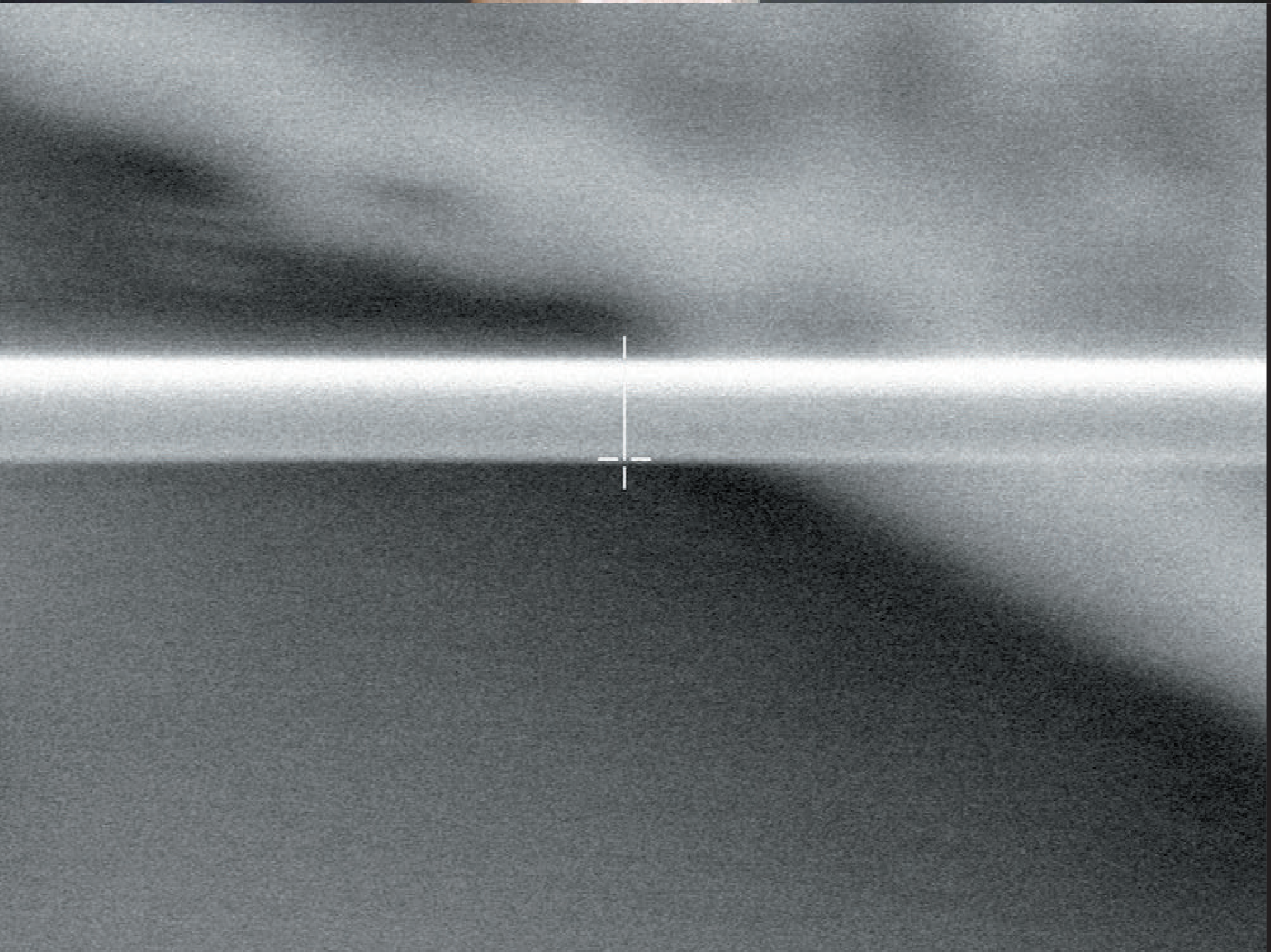

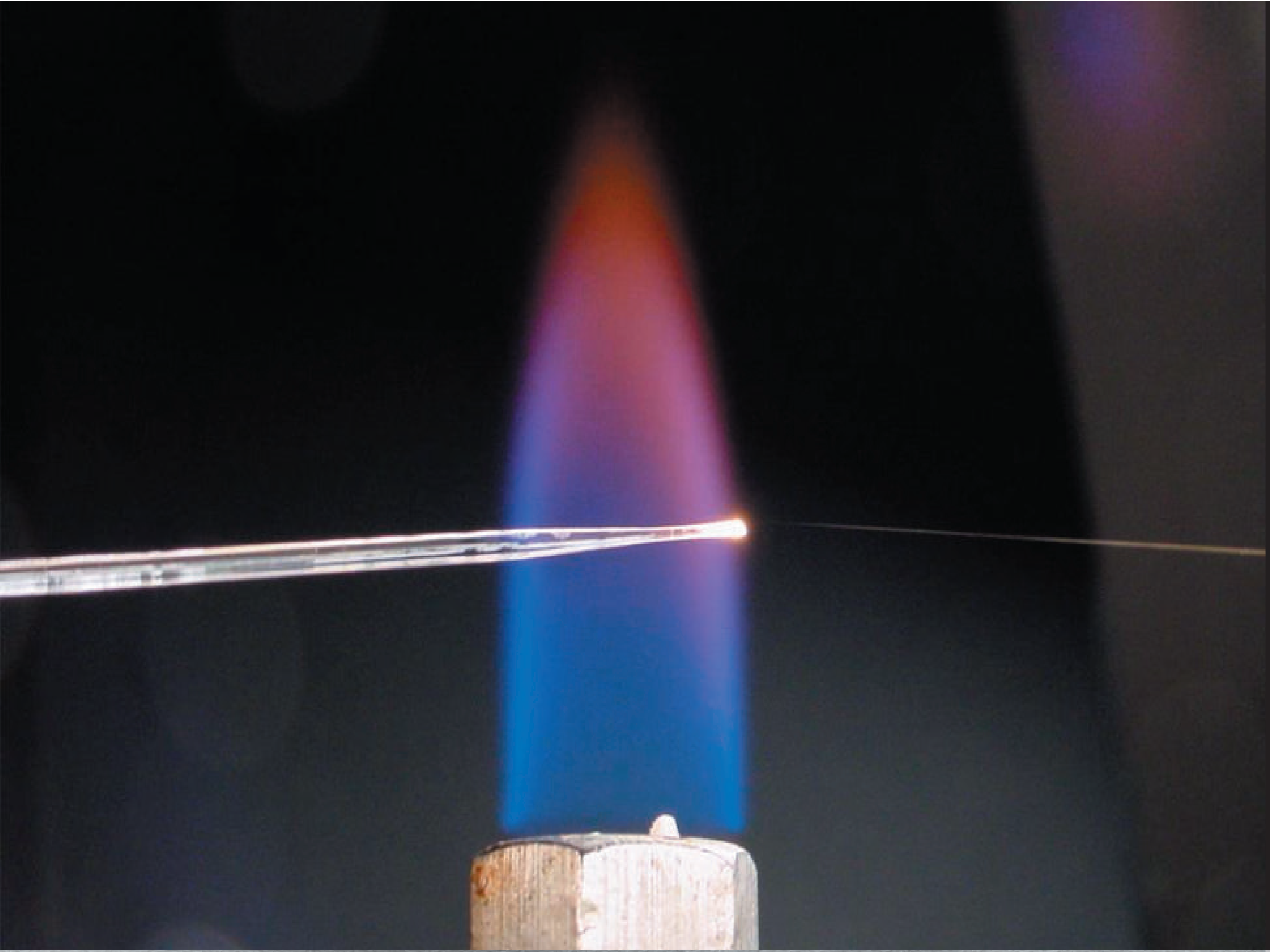

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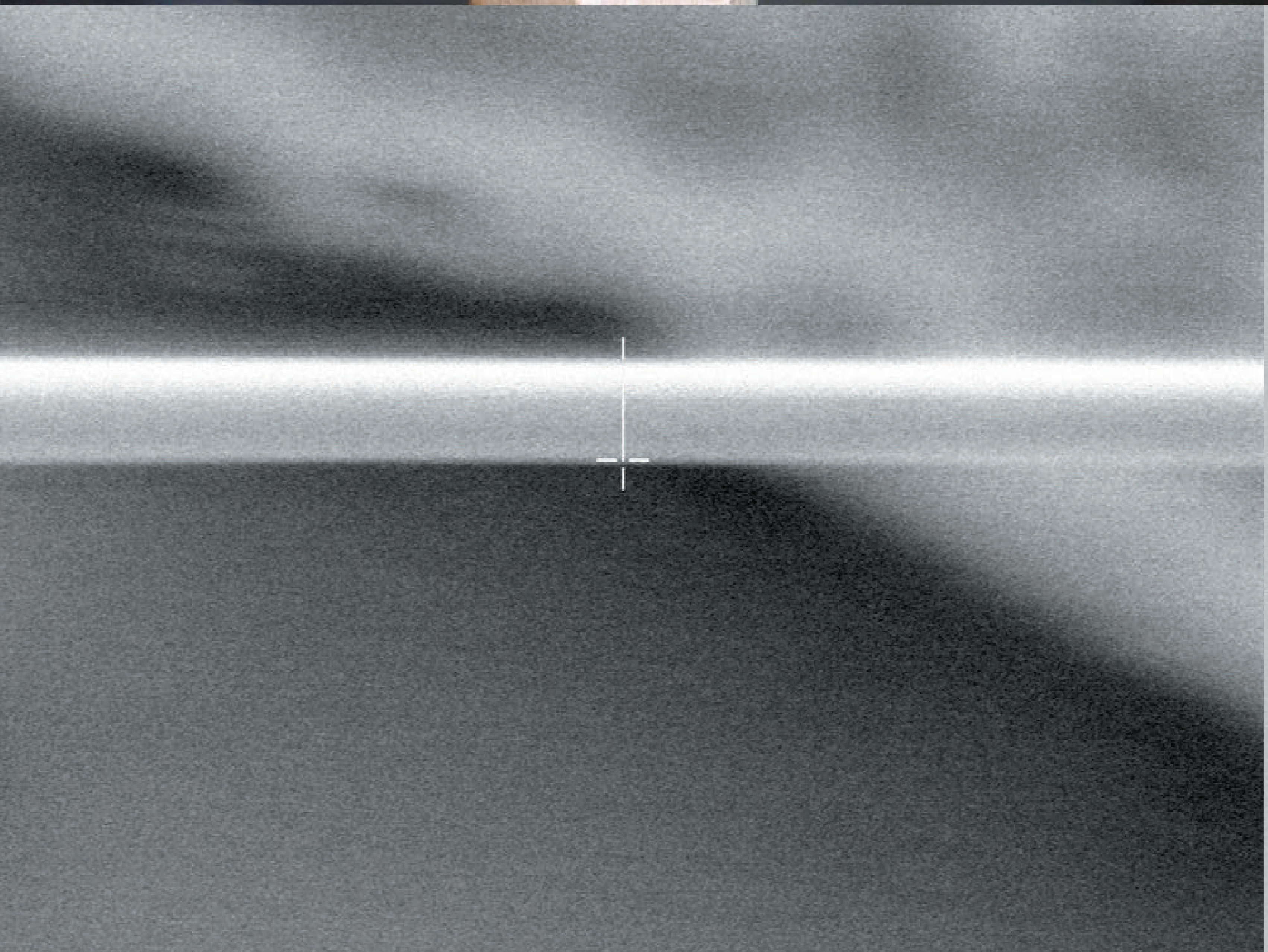
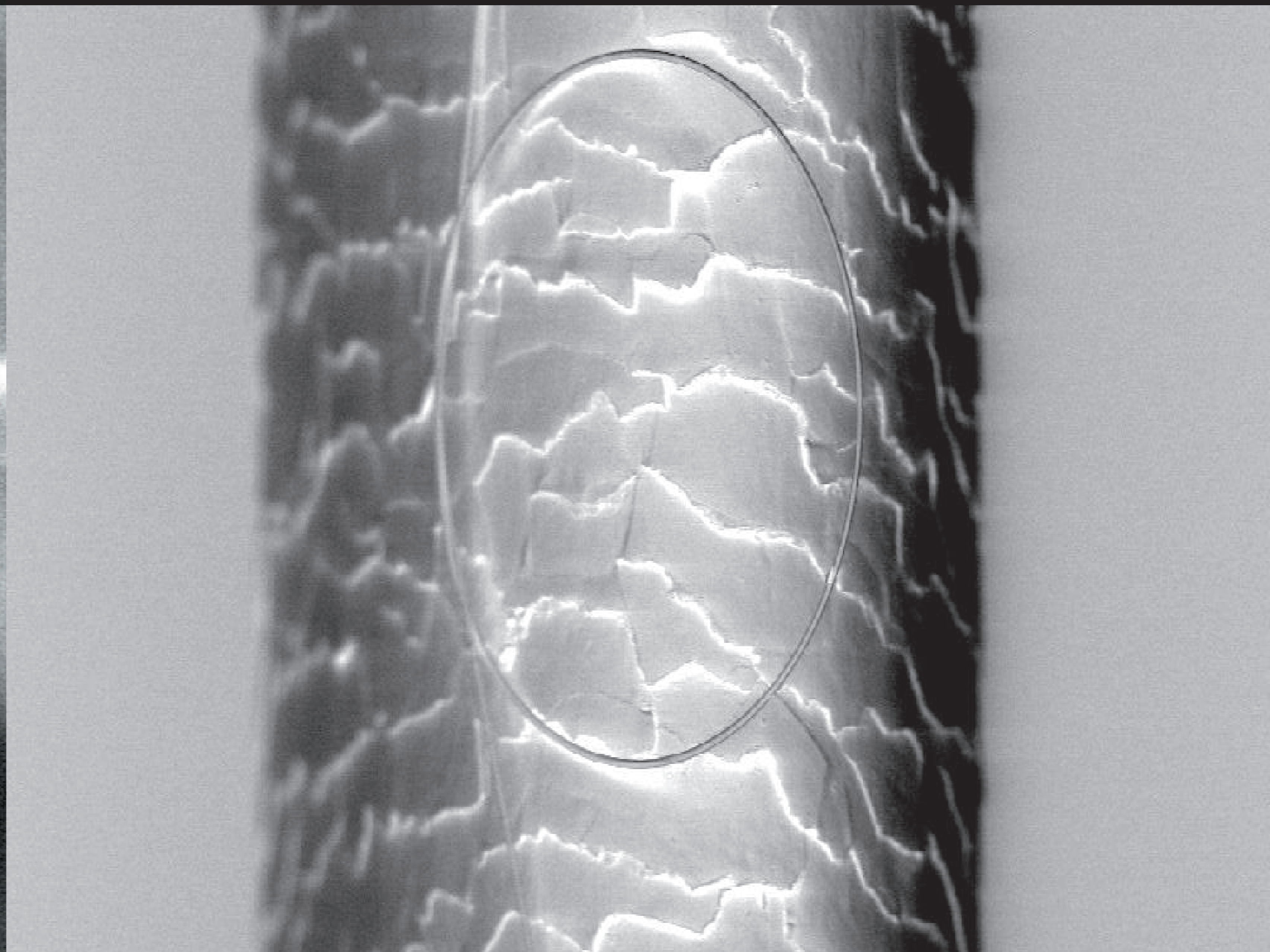
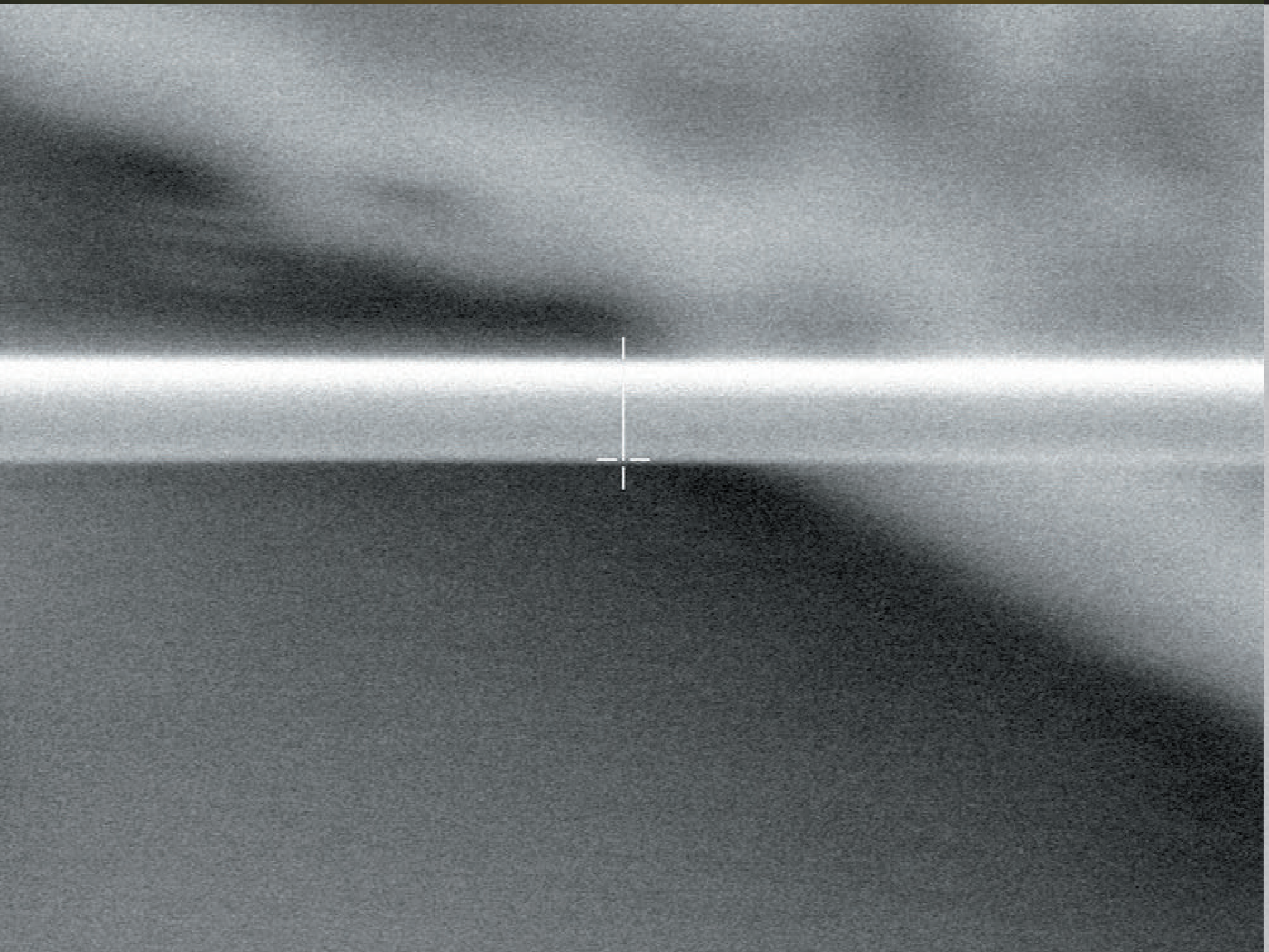
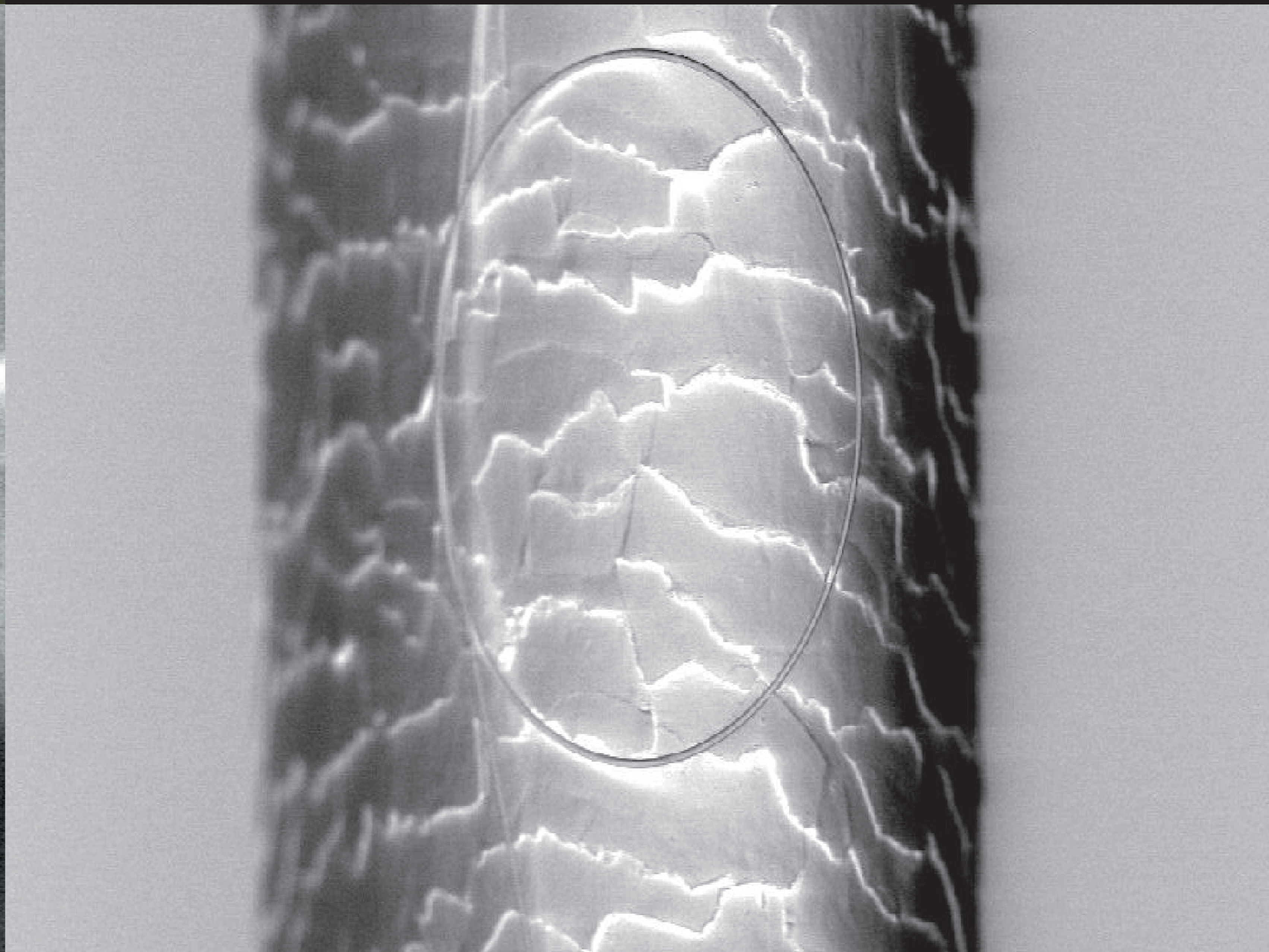
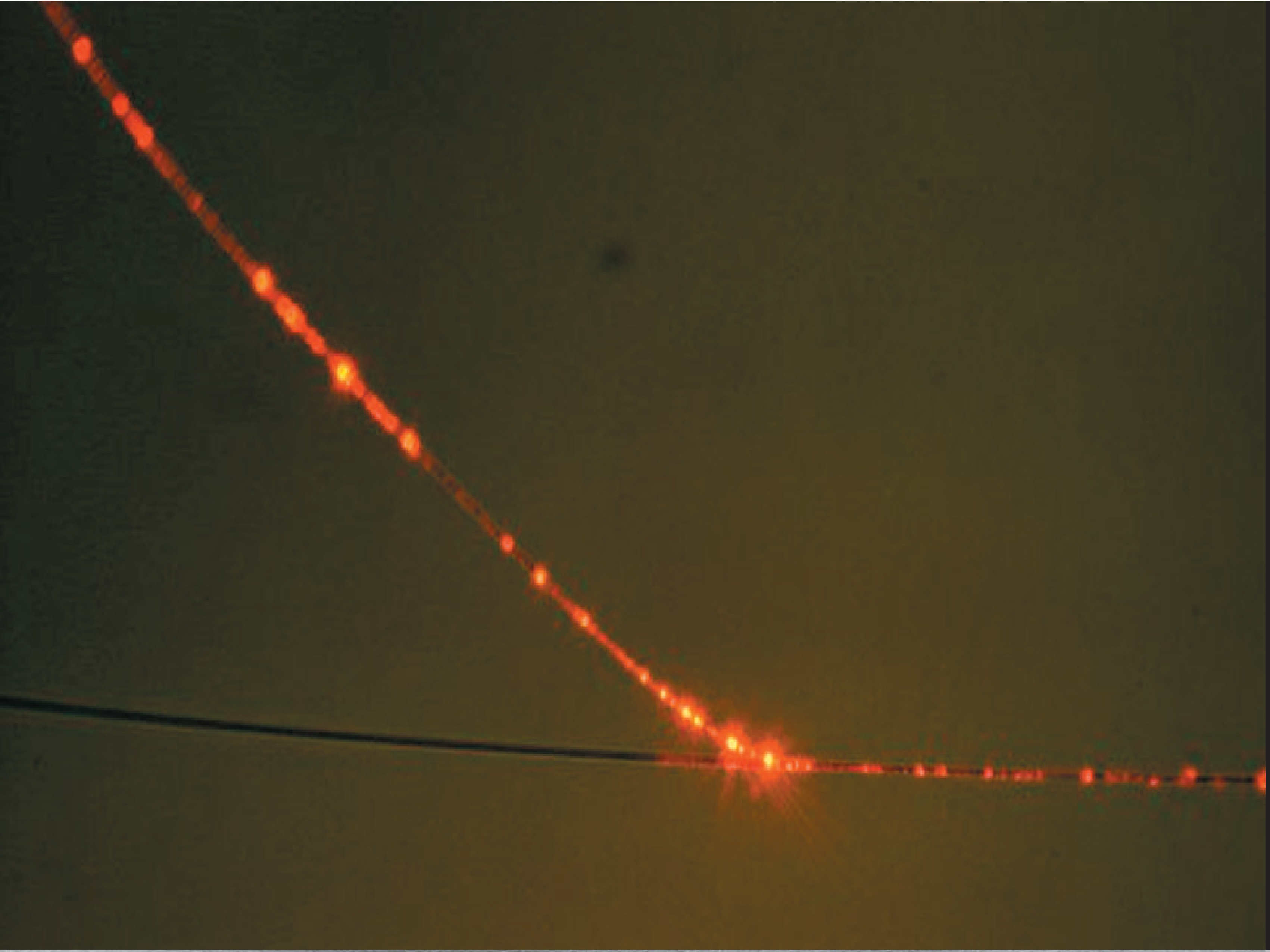




they guide light!







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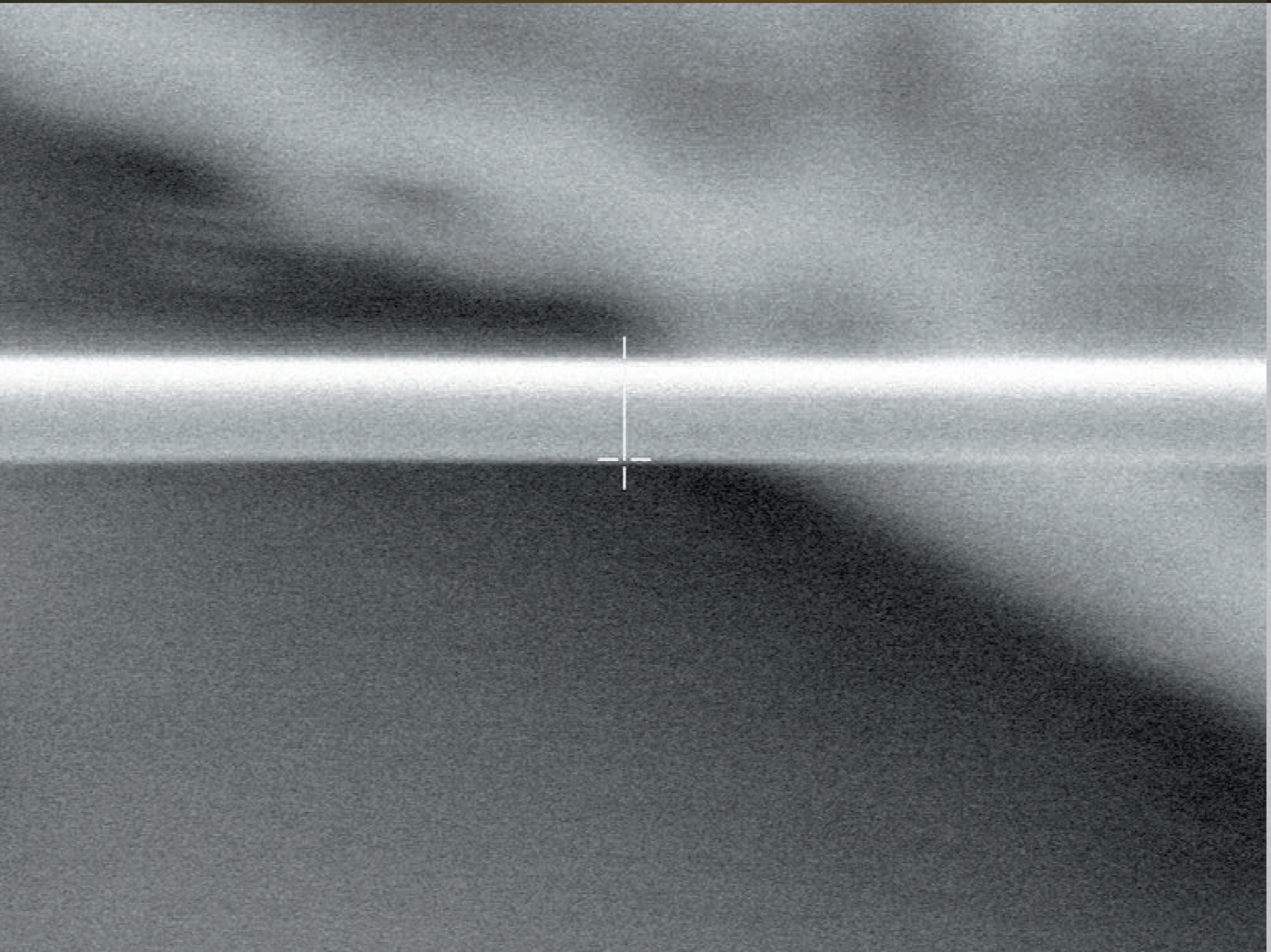

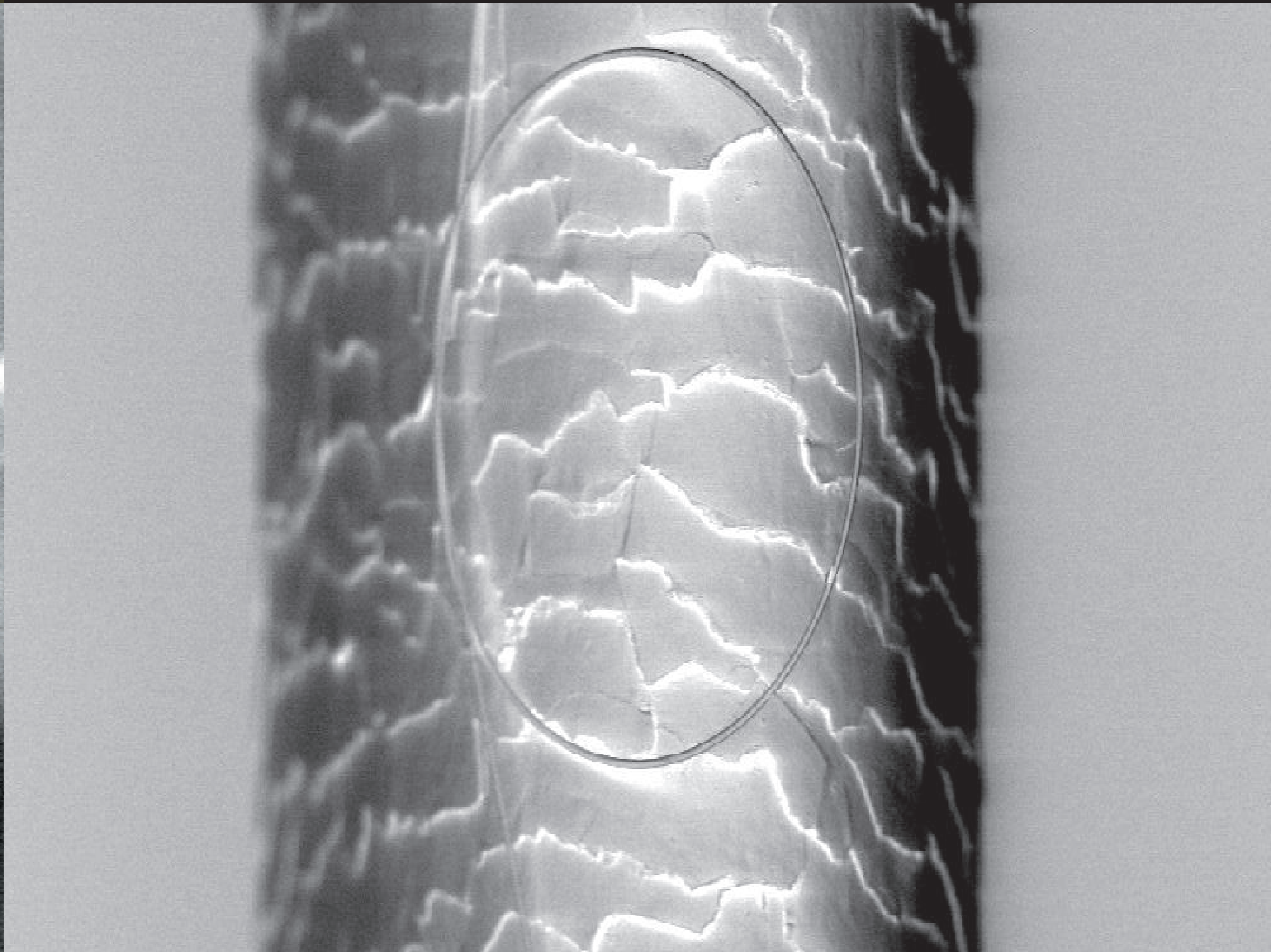

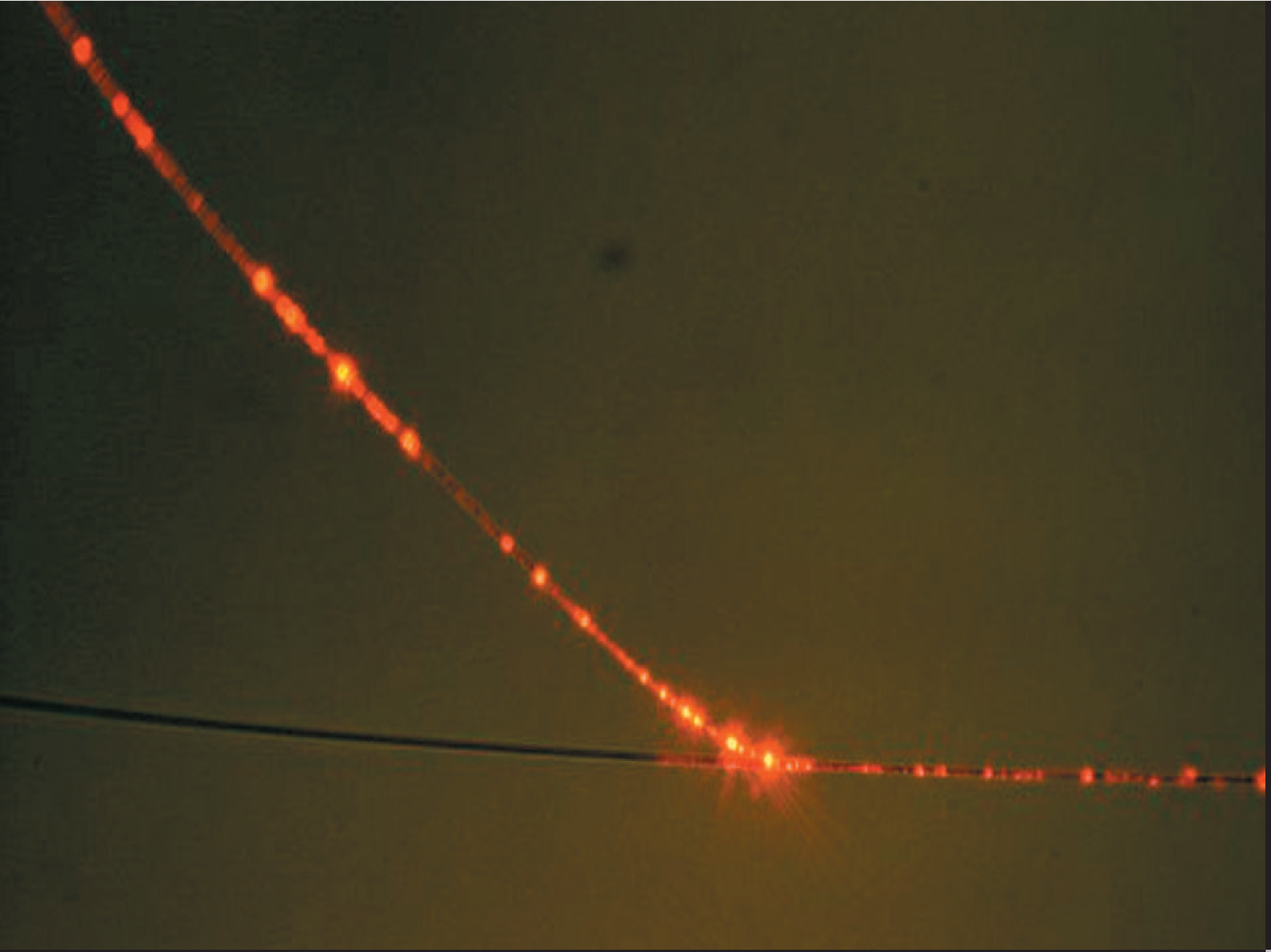

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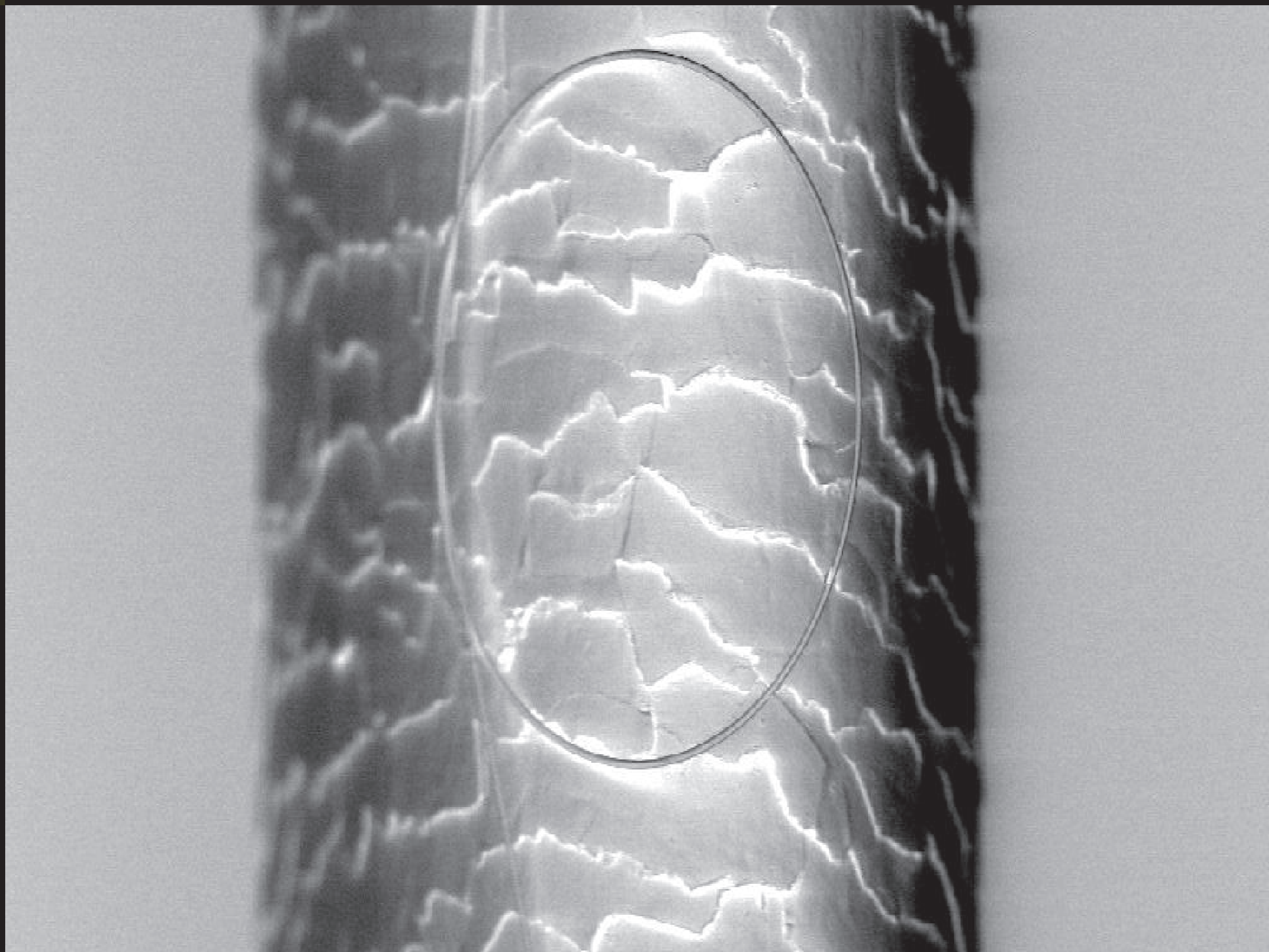

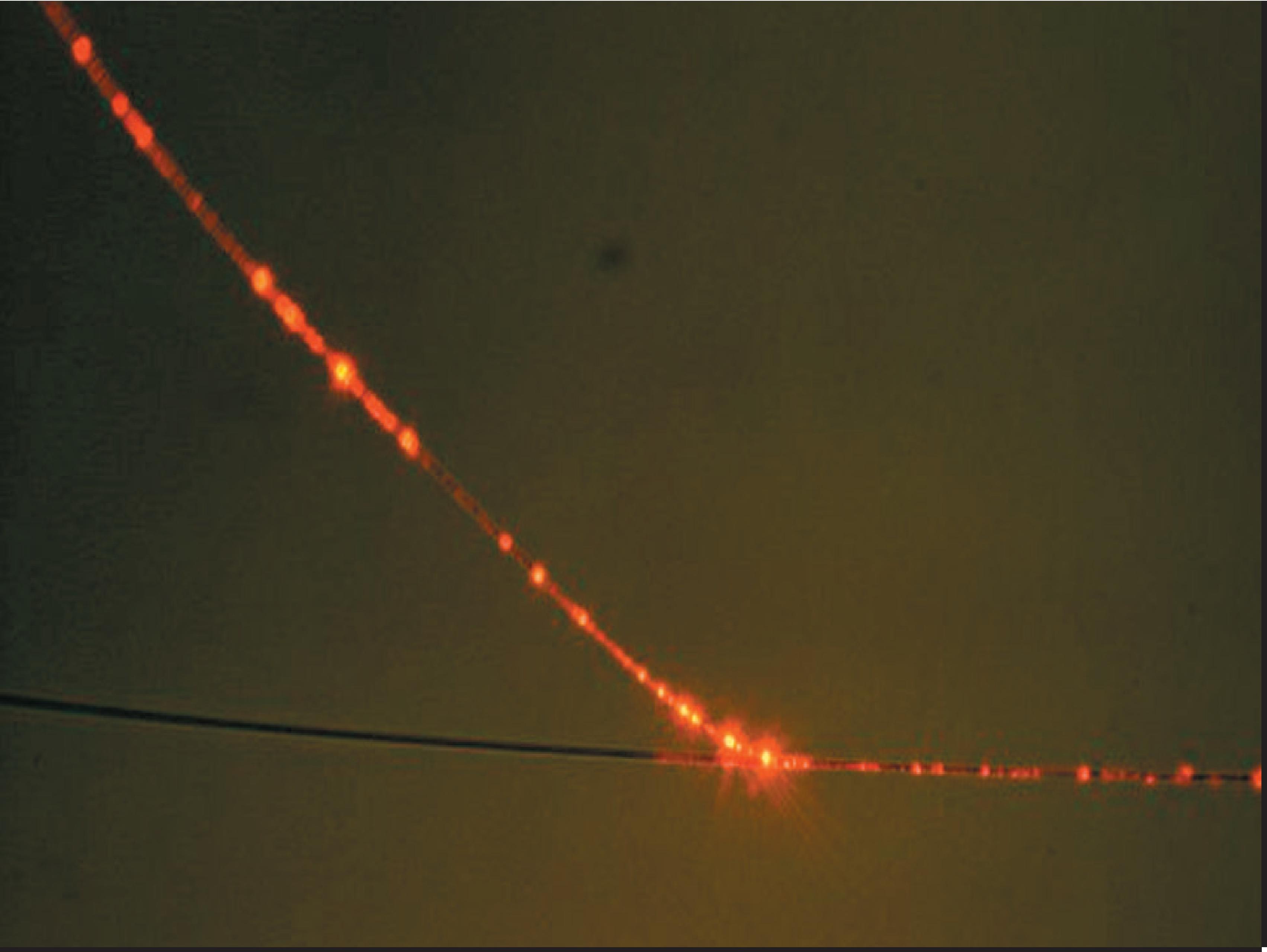

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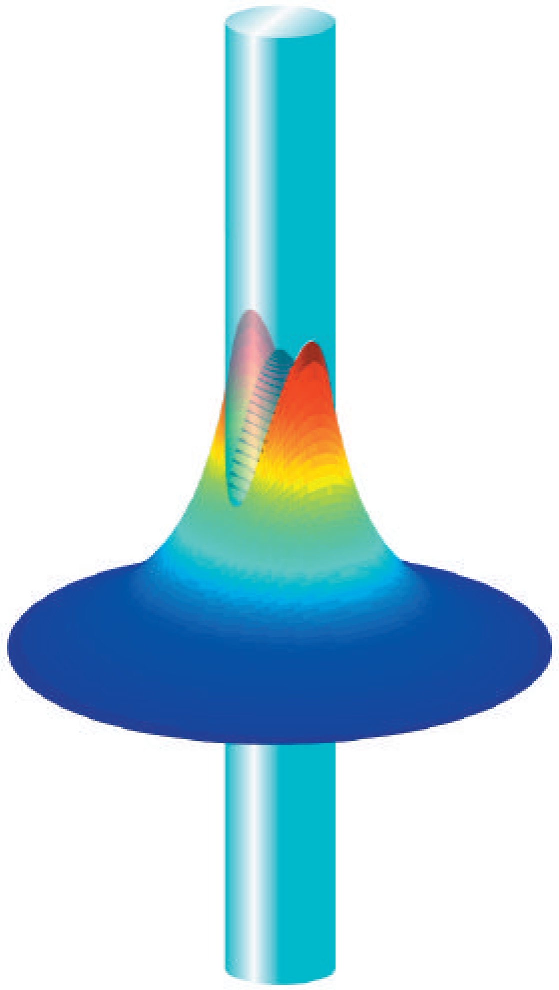

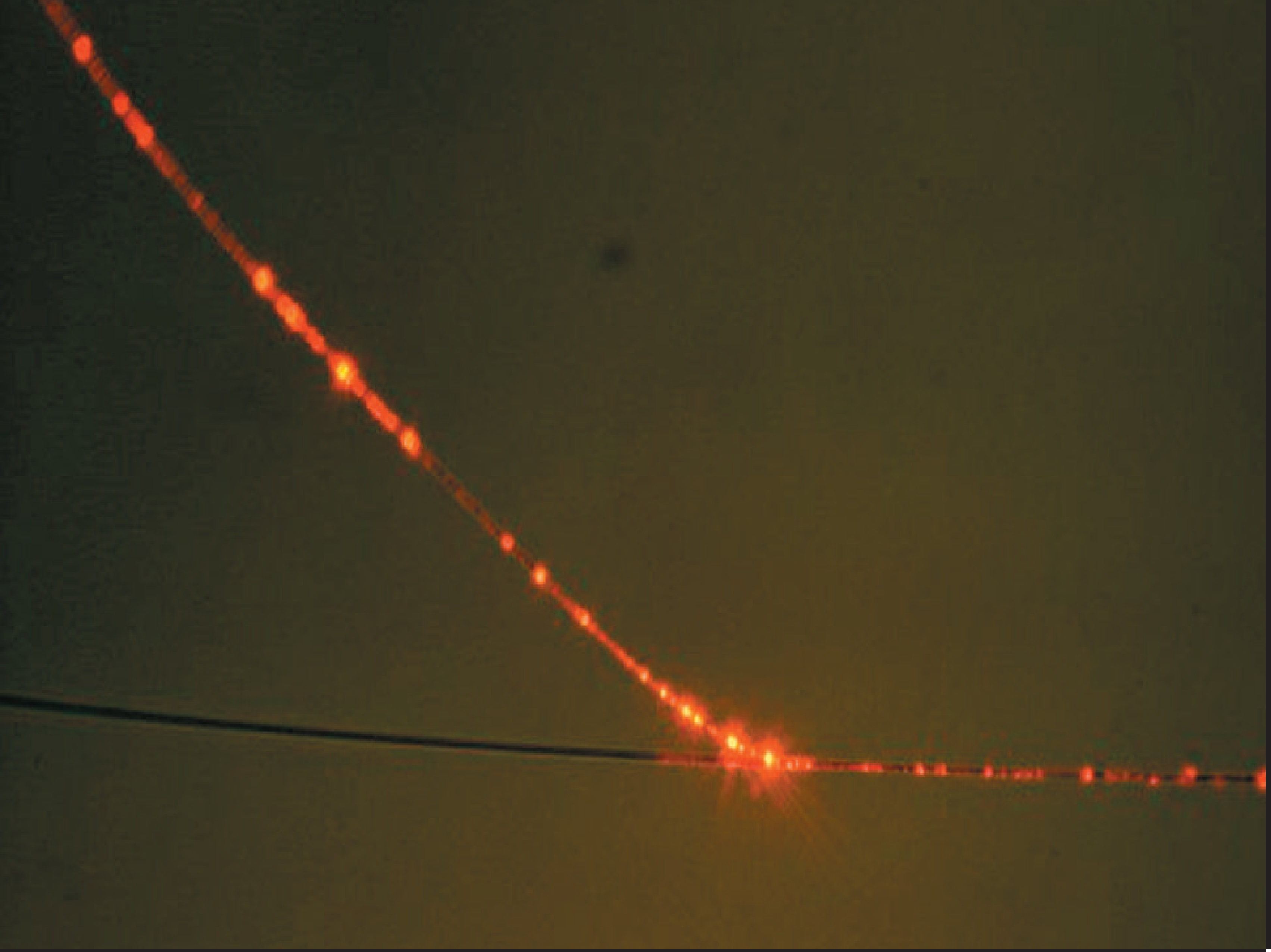

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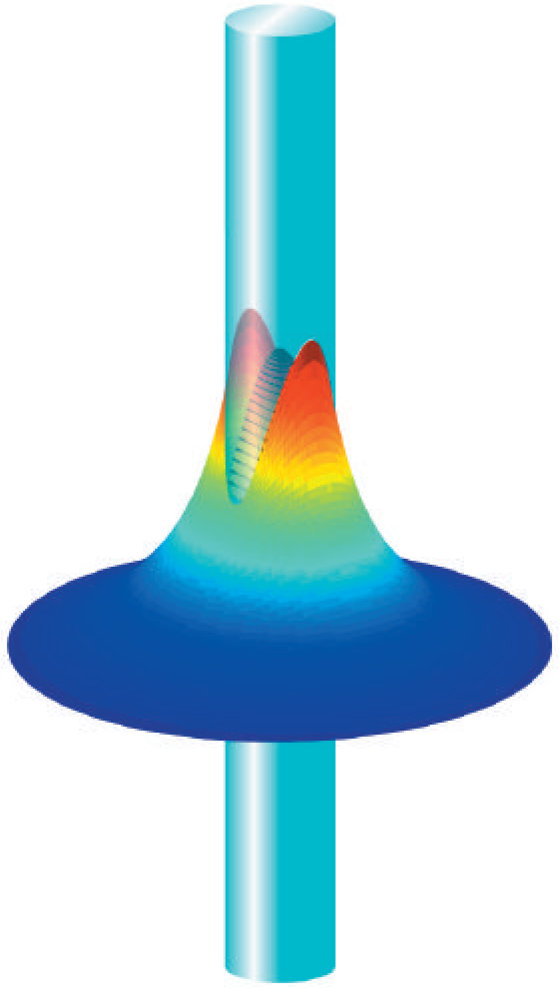
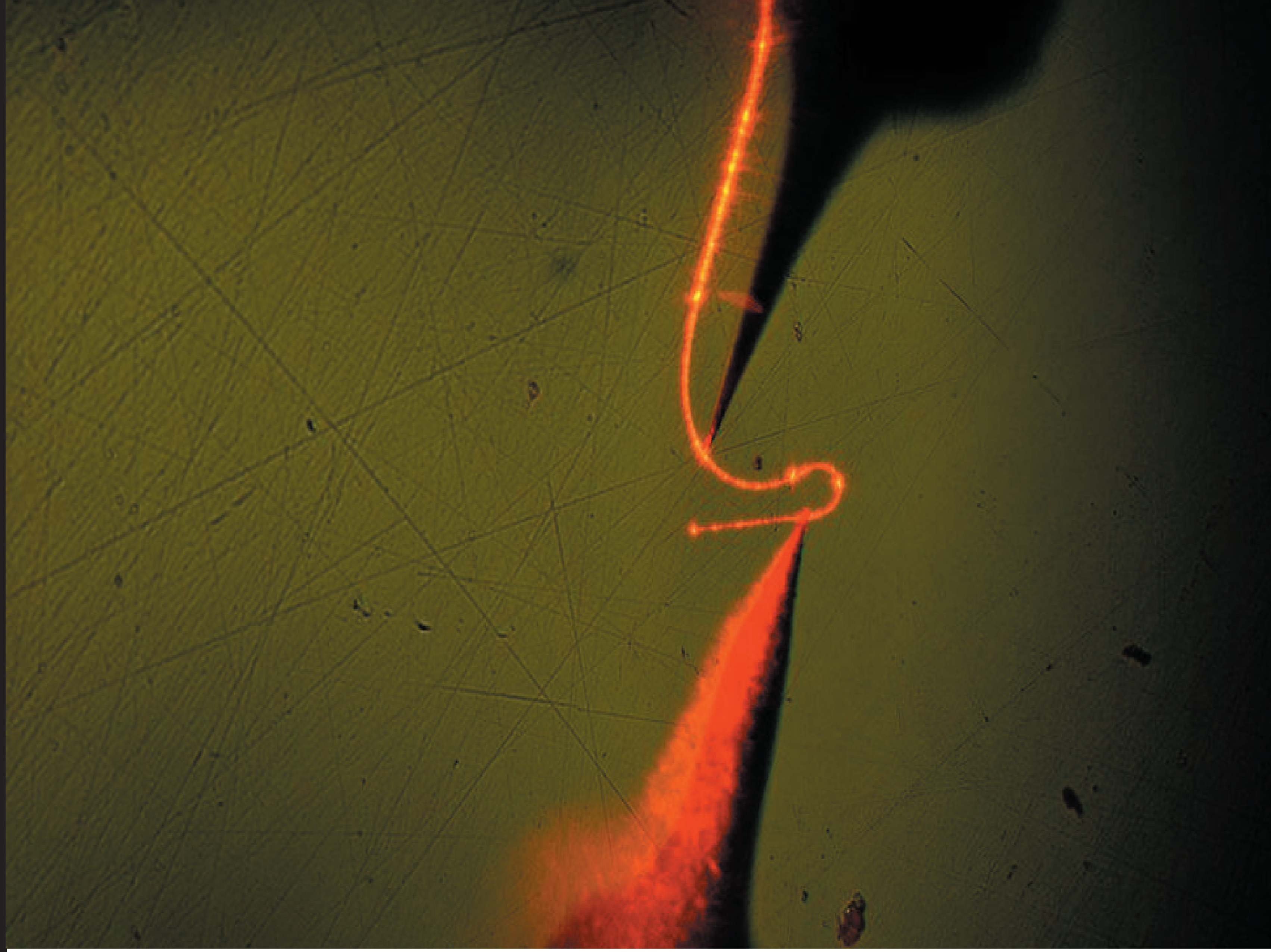
…as a ‘rail’ for light!



they can bend light tightly



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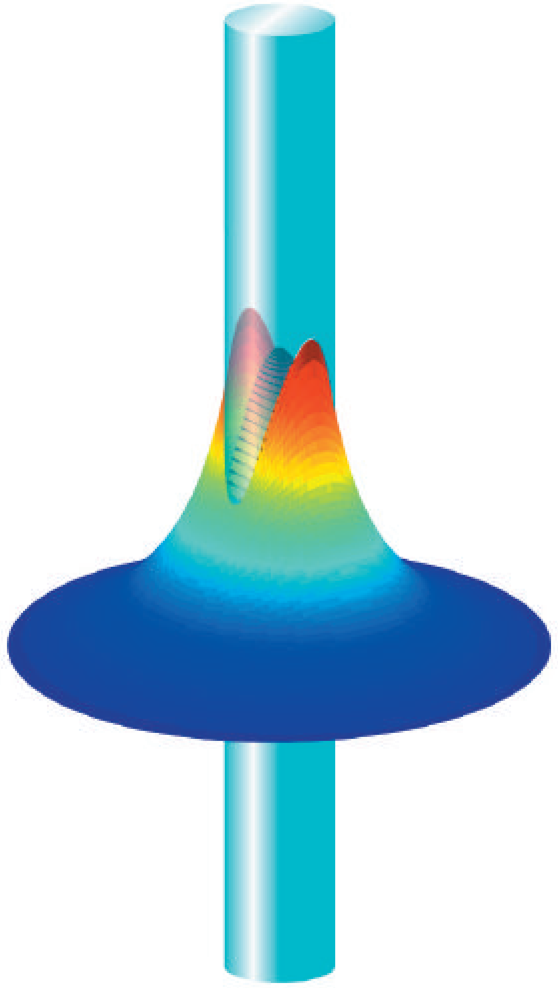

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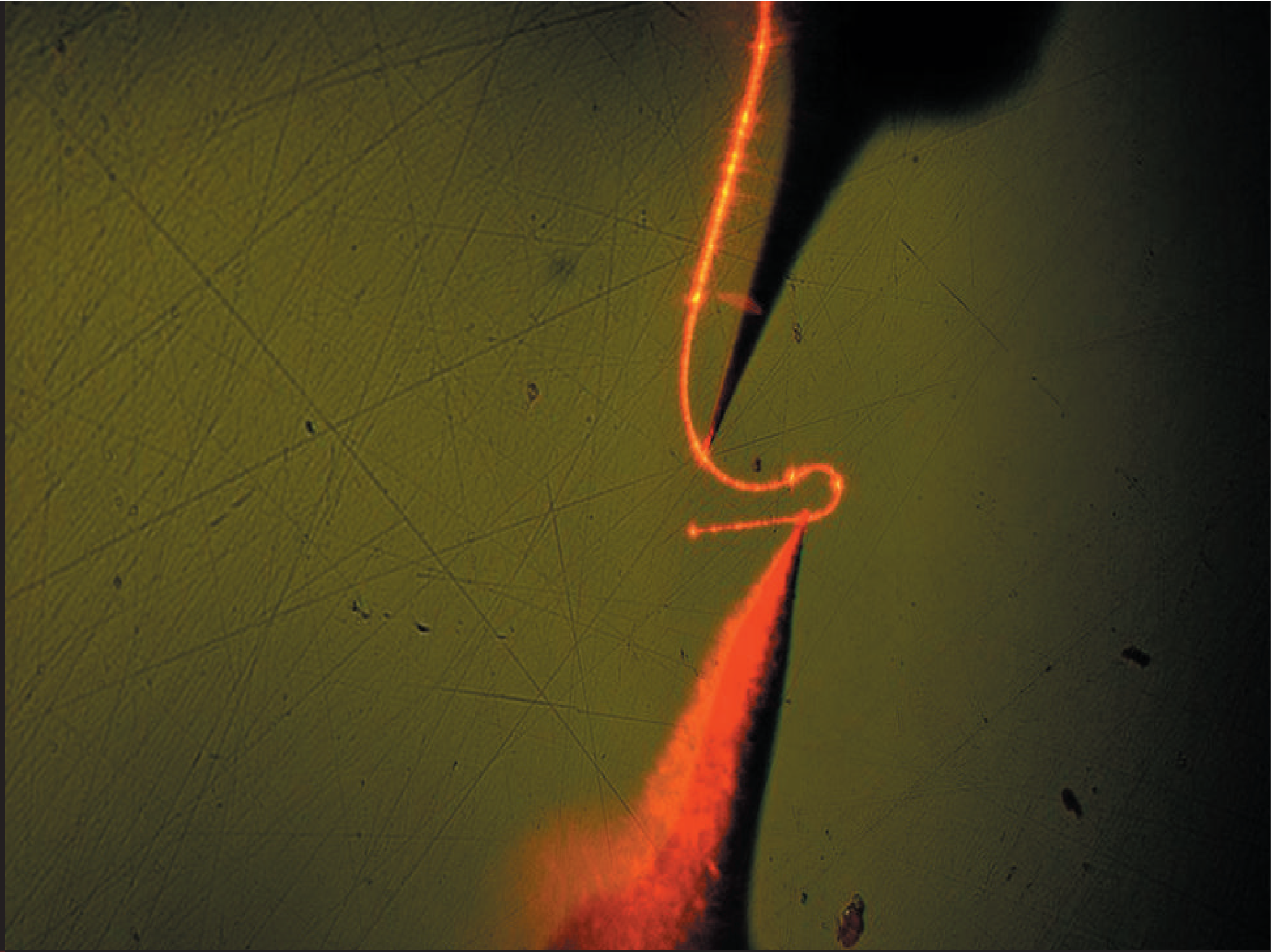
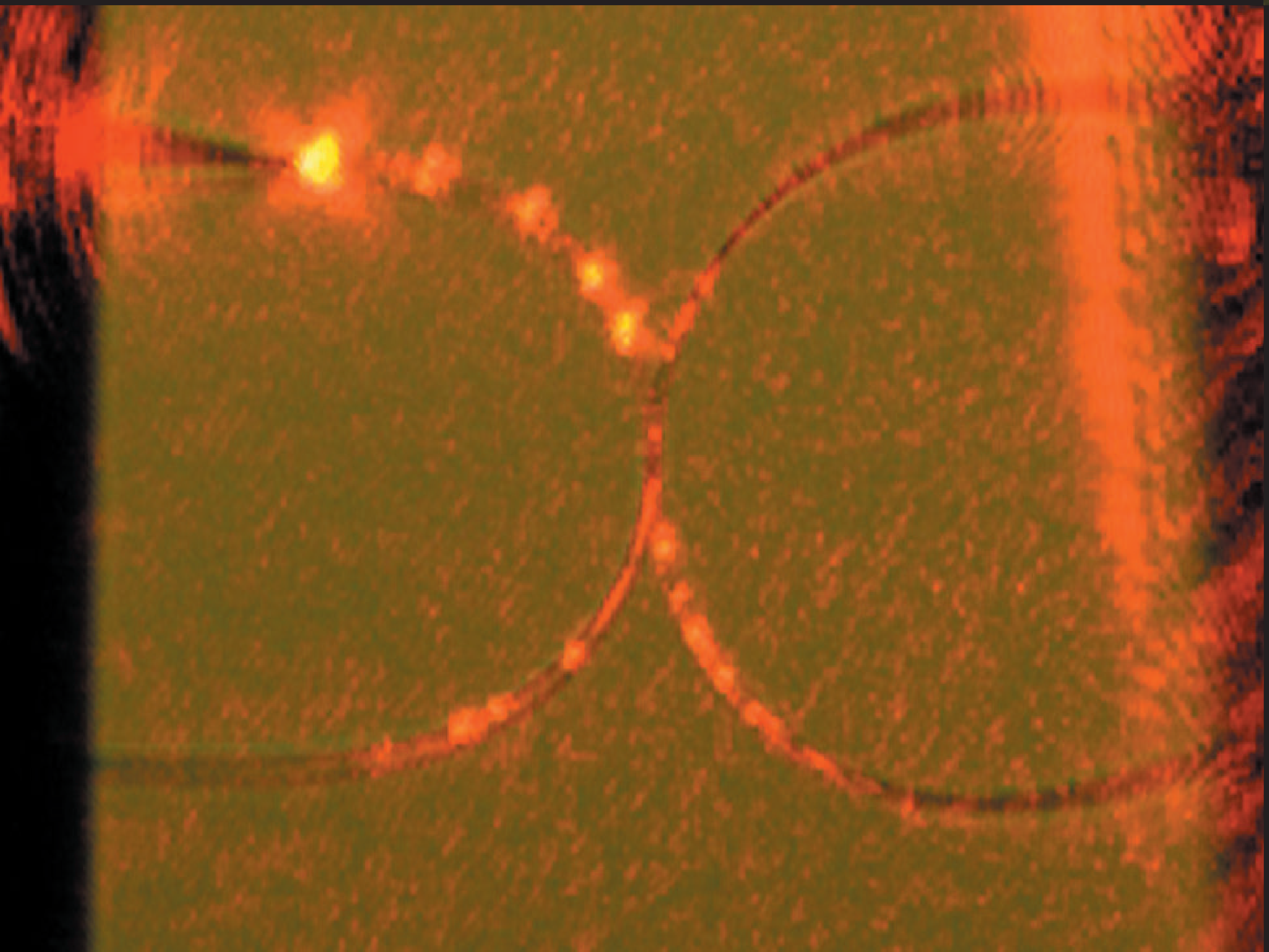
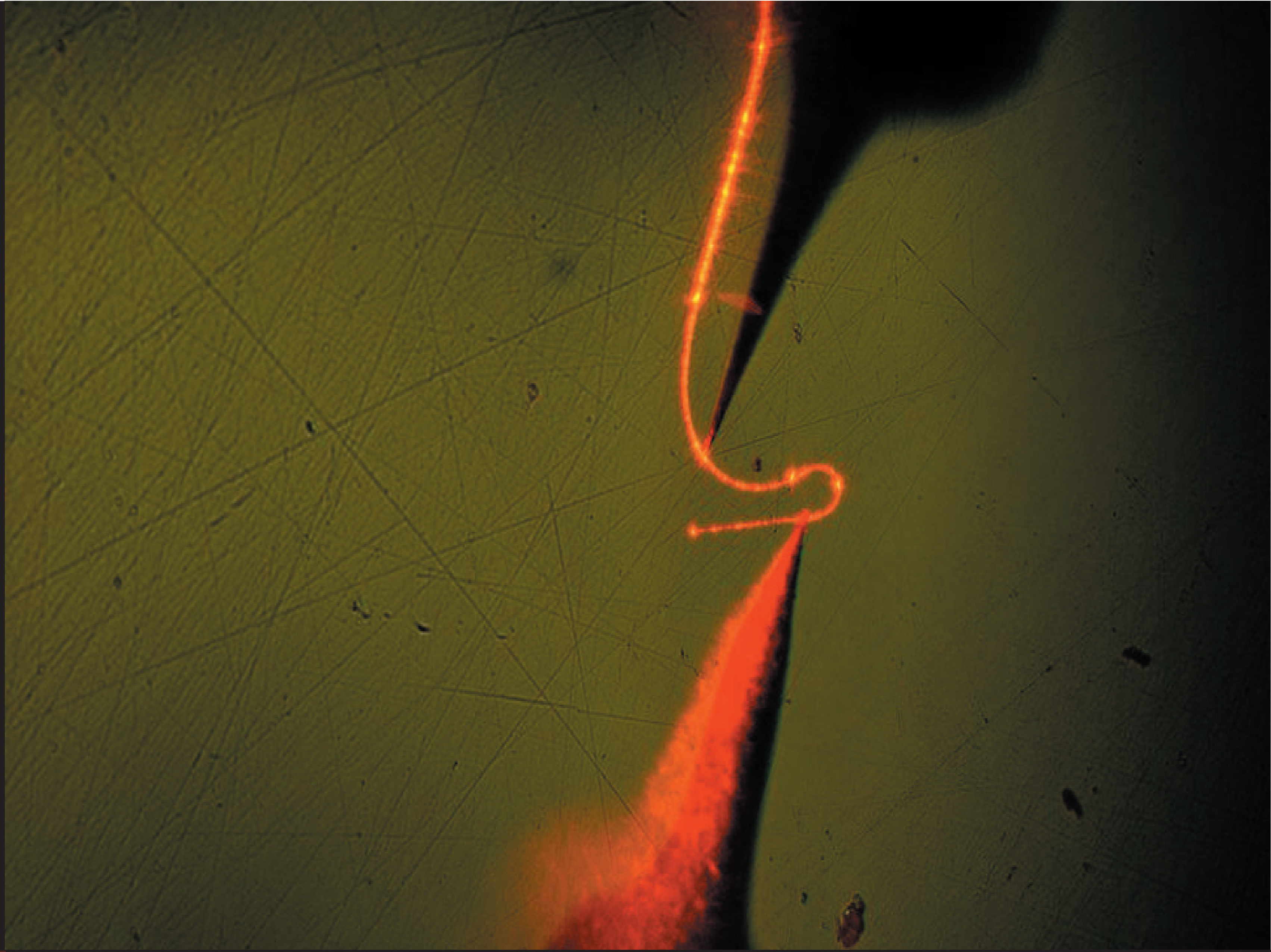


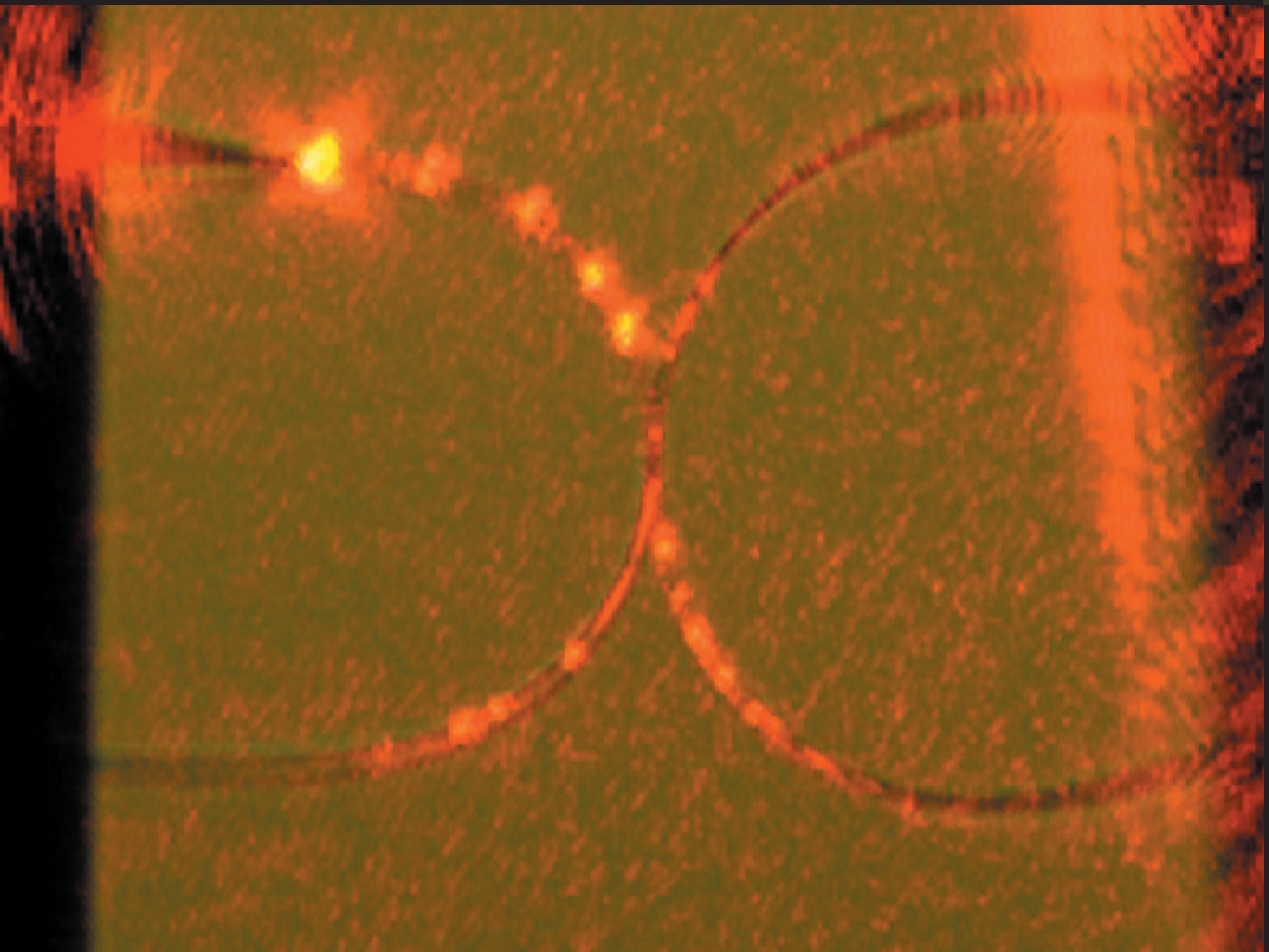


Applications:

- ‘nanophotonics’
- sensors

Why is smaller better?





- faster

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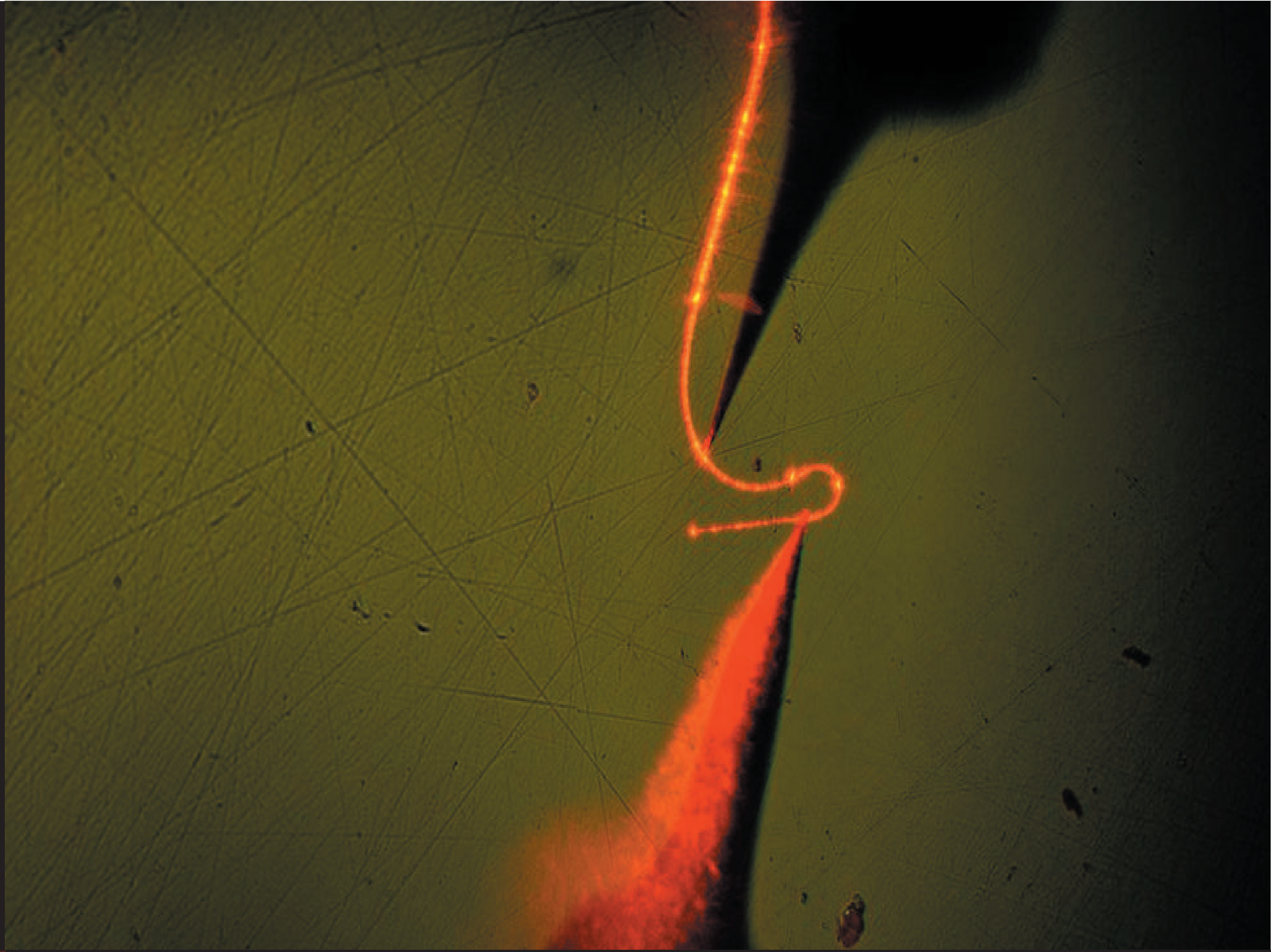

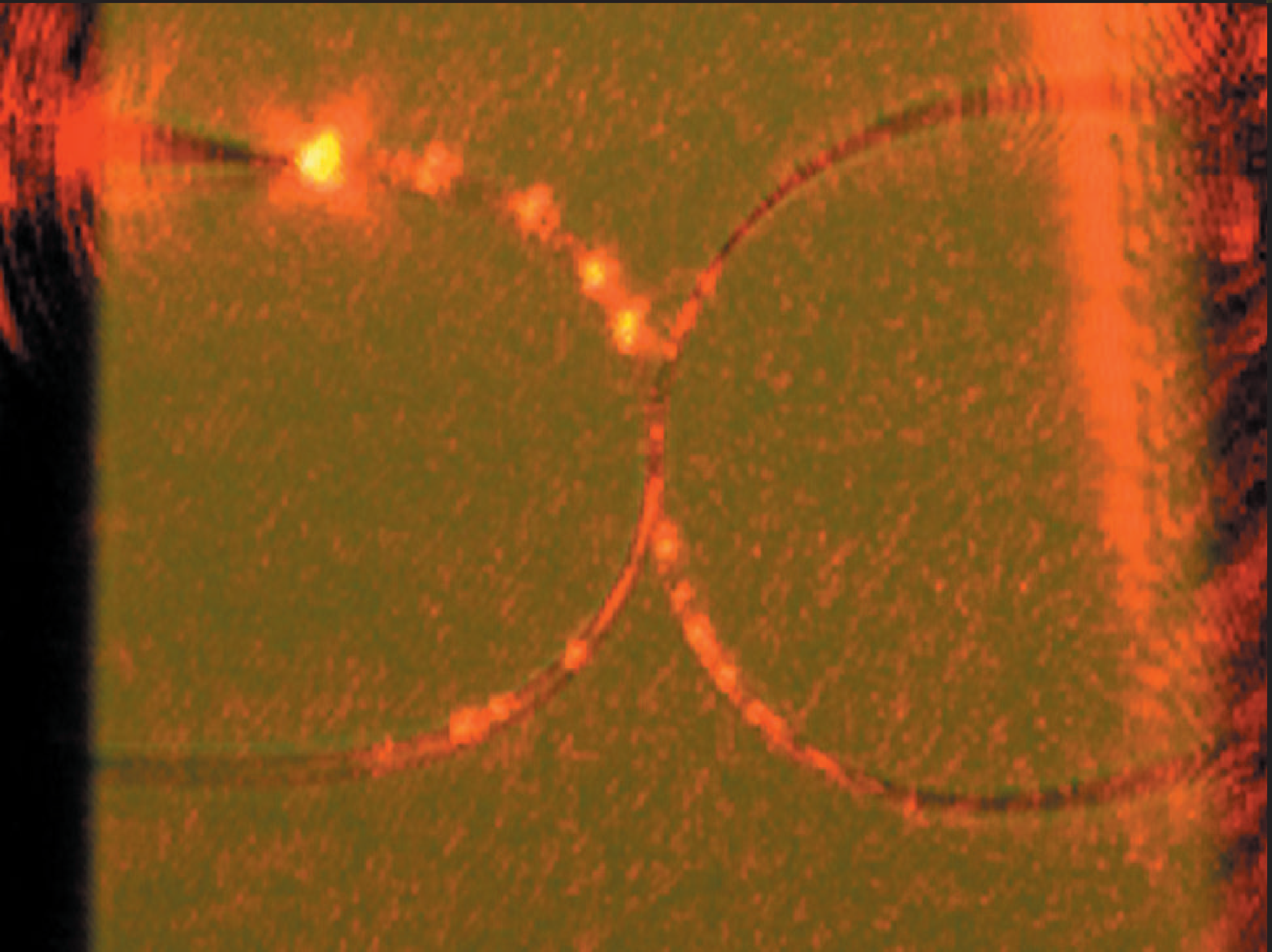

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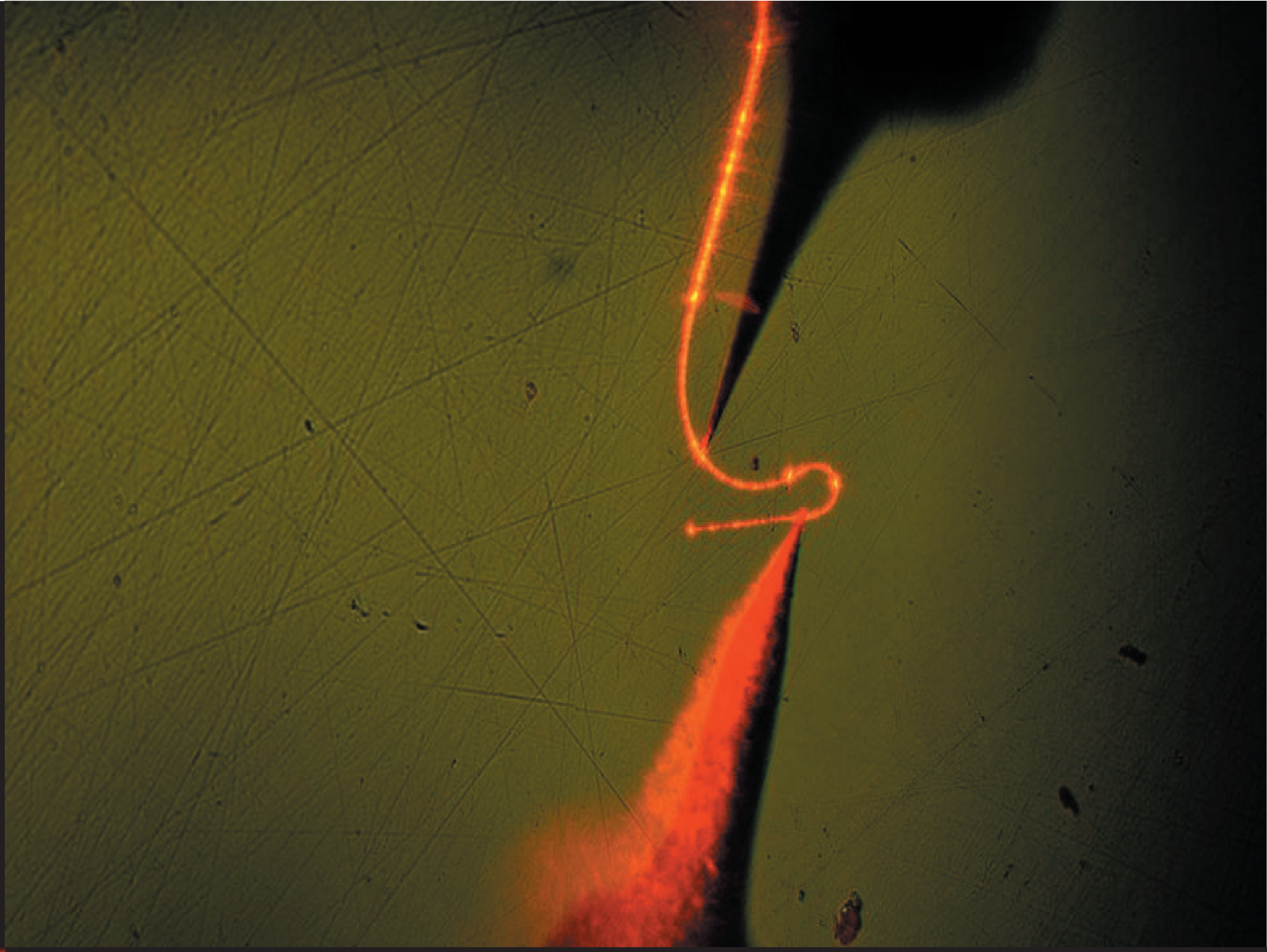

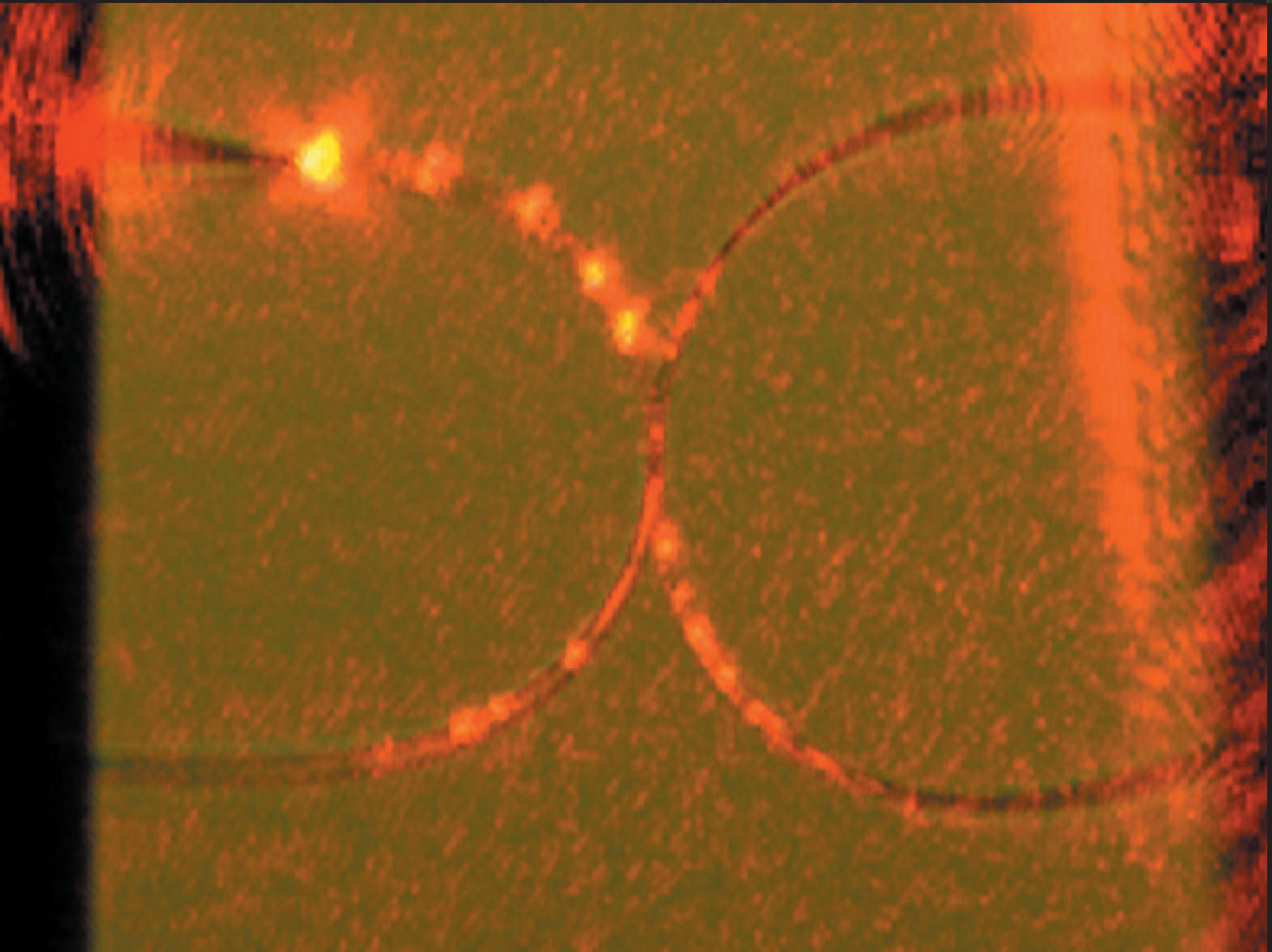

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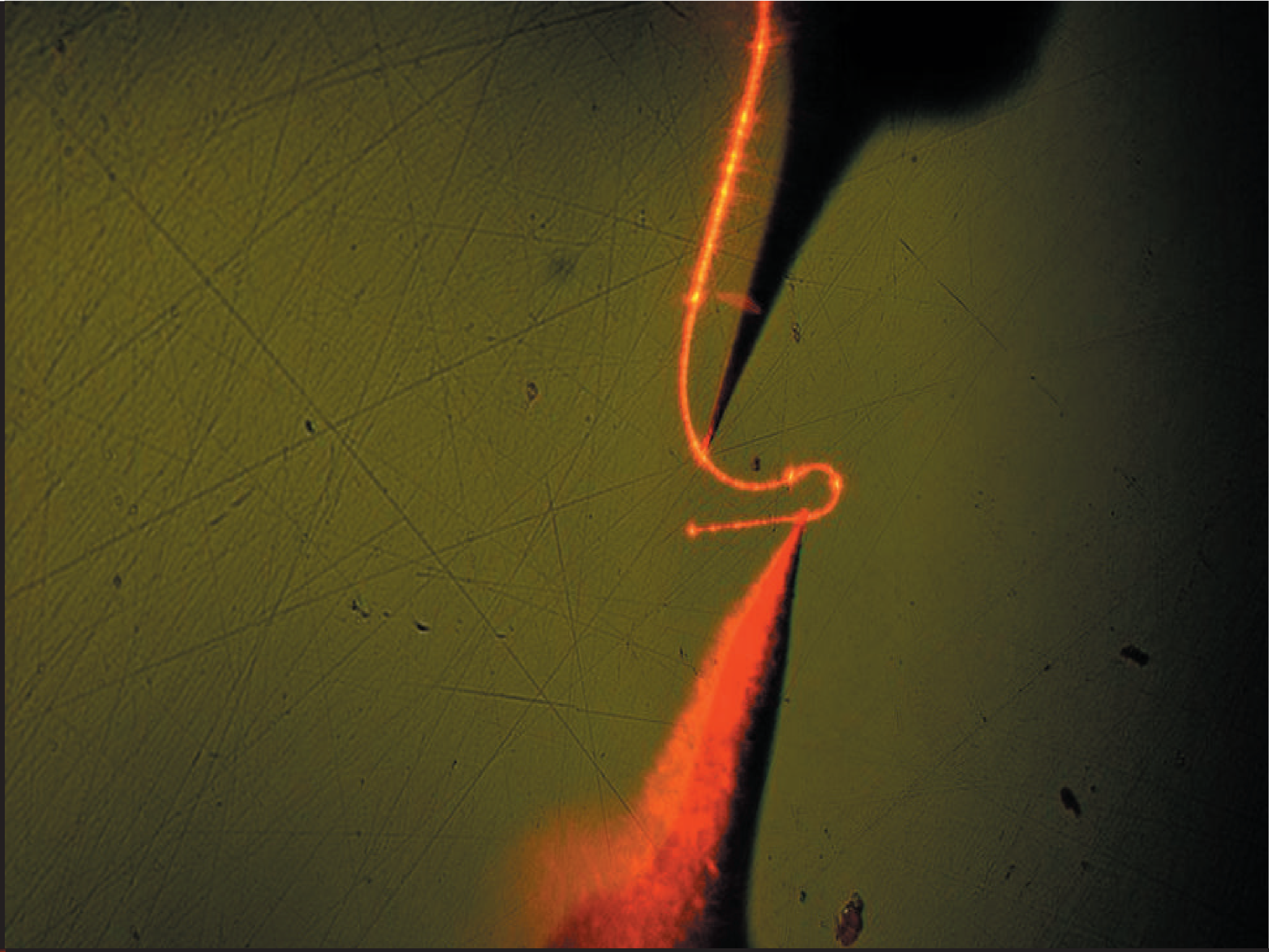

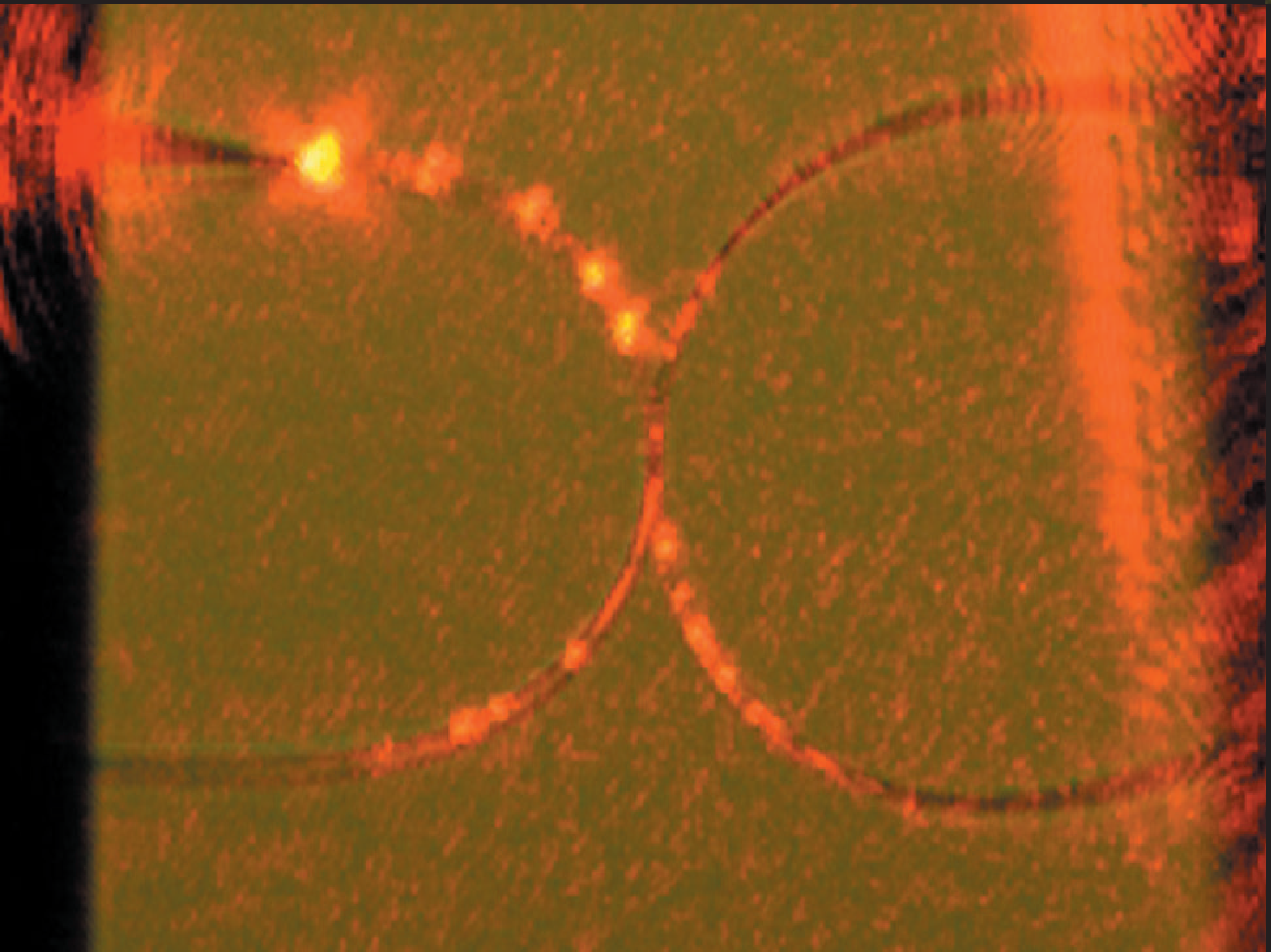

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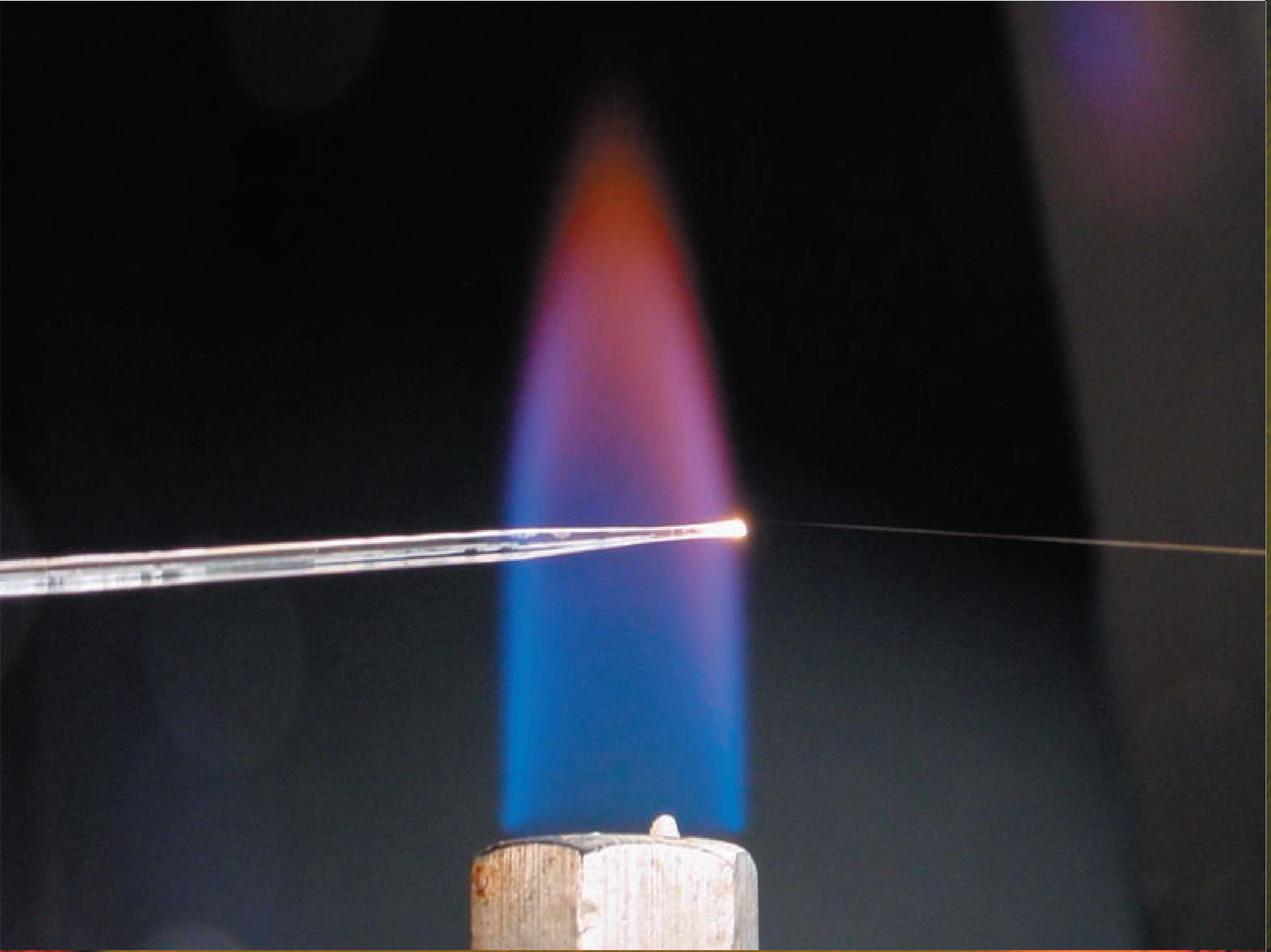

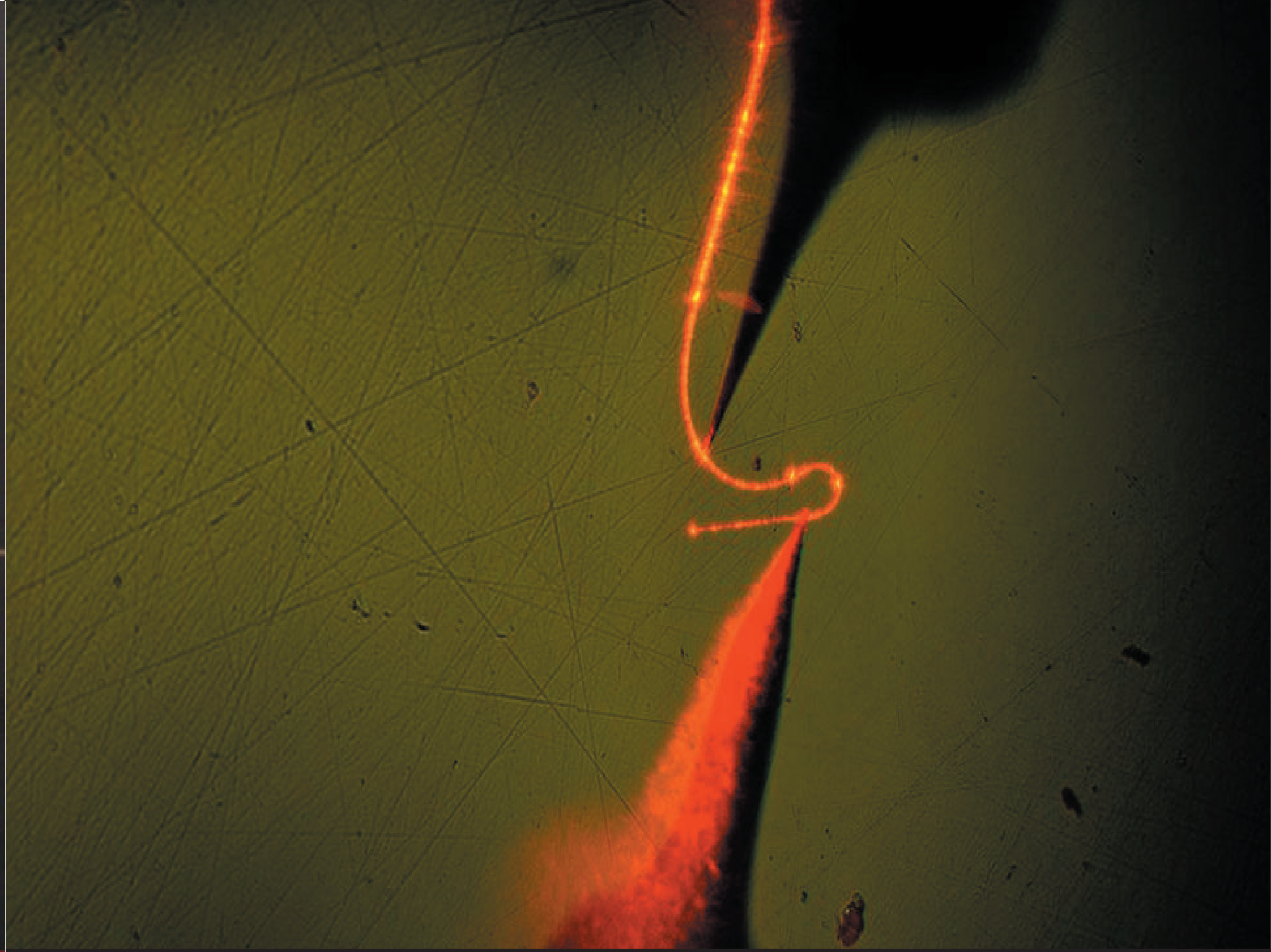

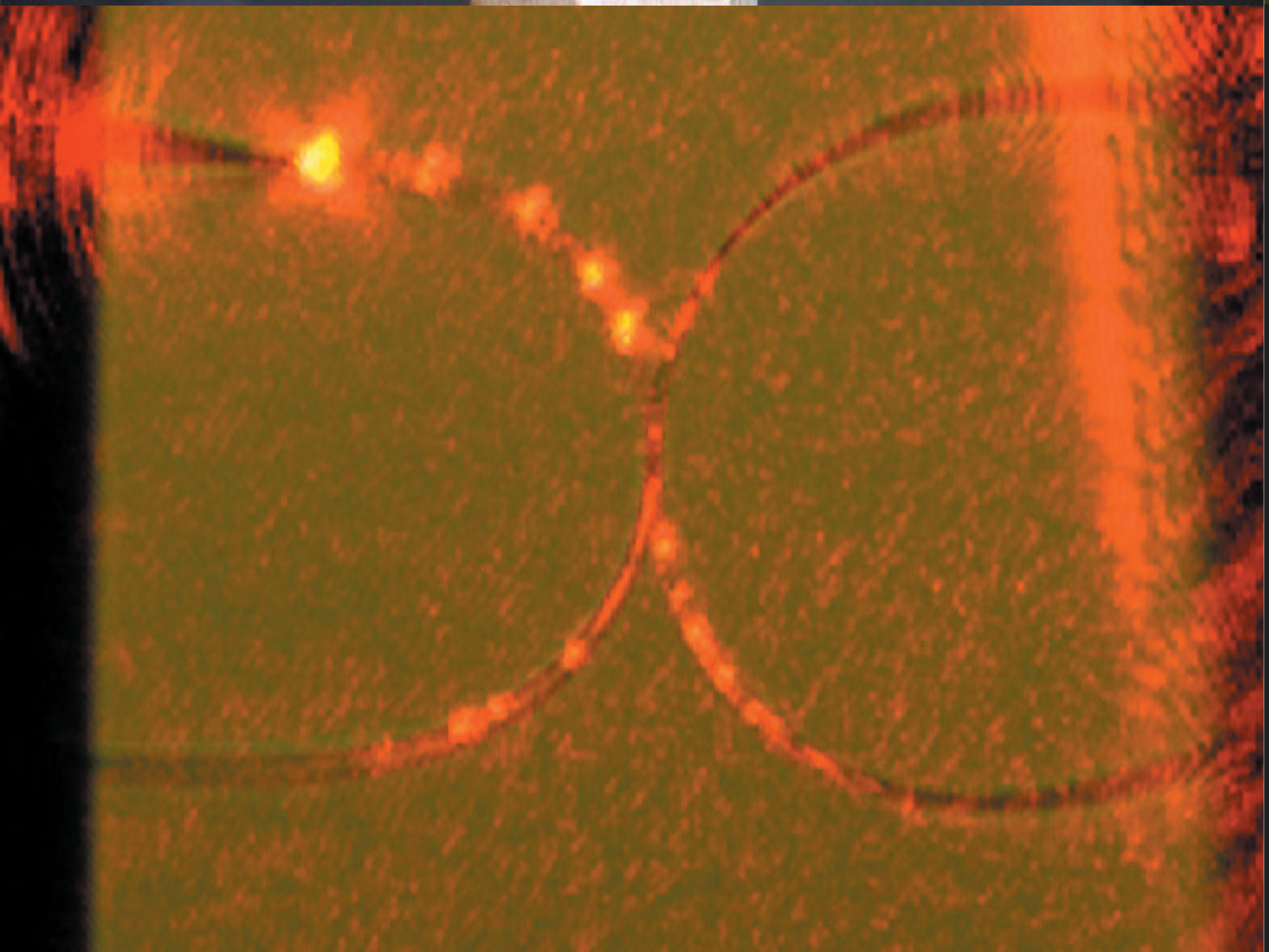

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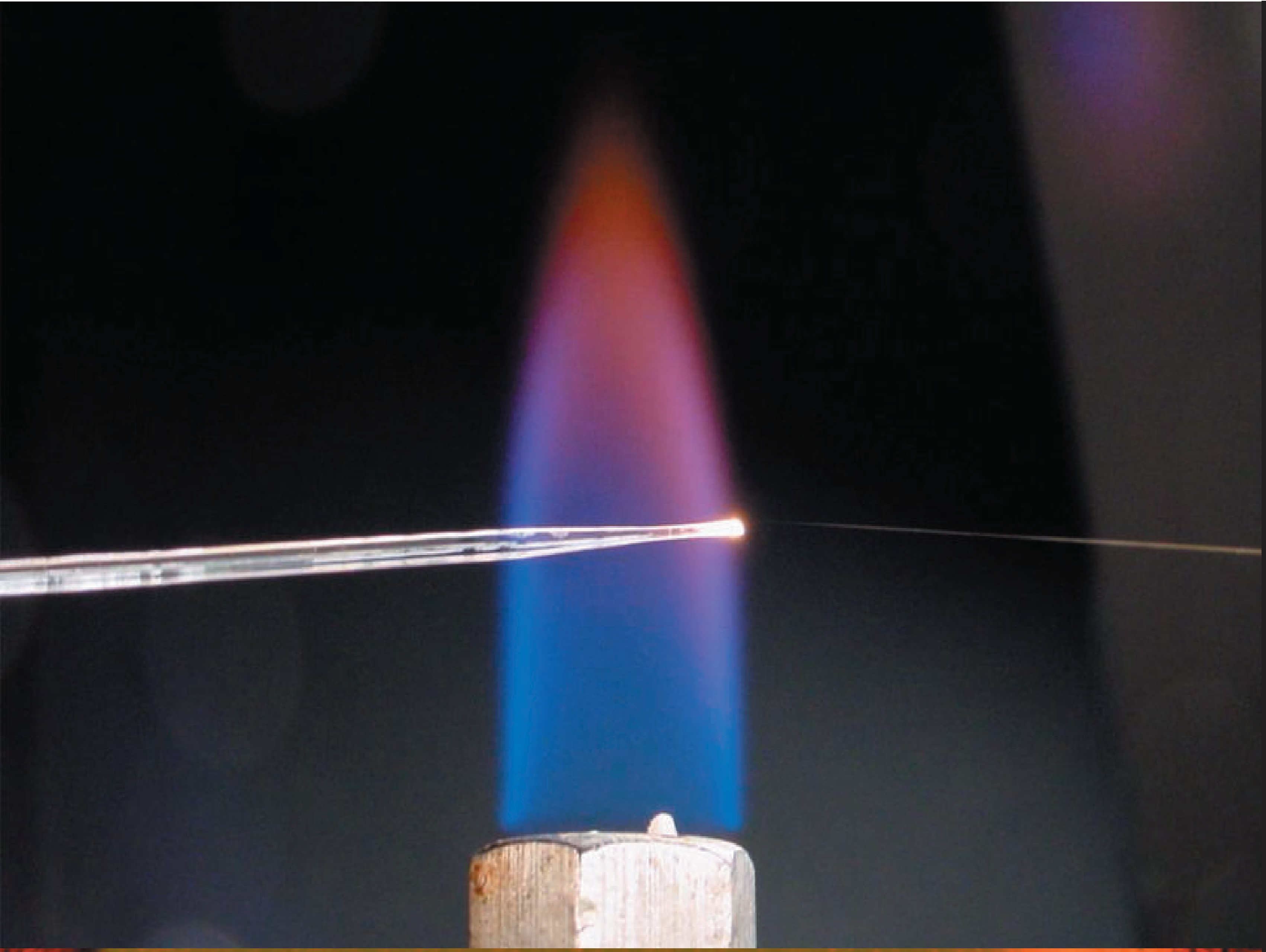

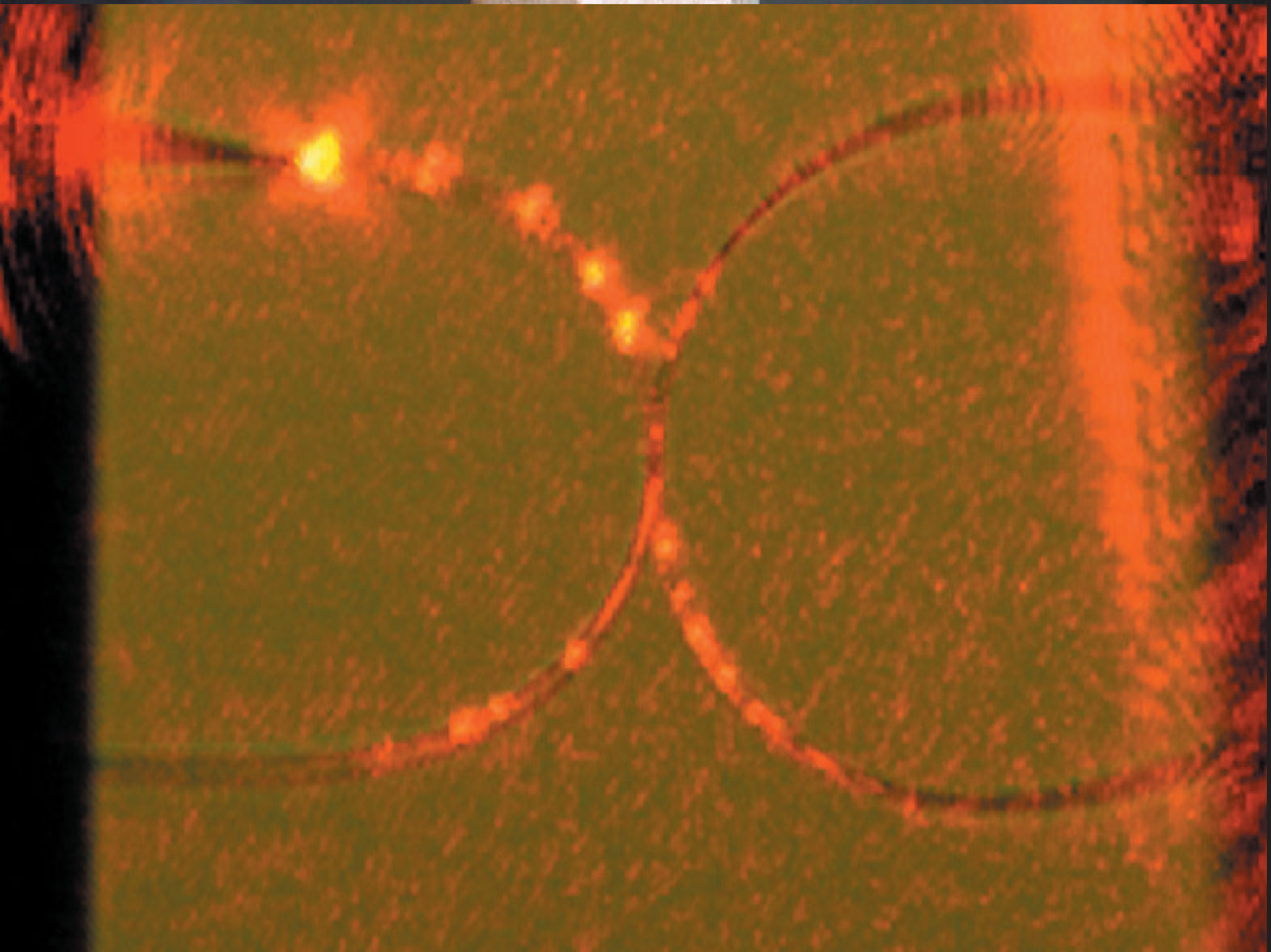

Nanotechnology can be simple!

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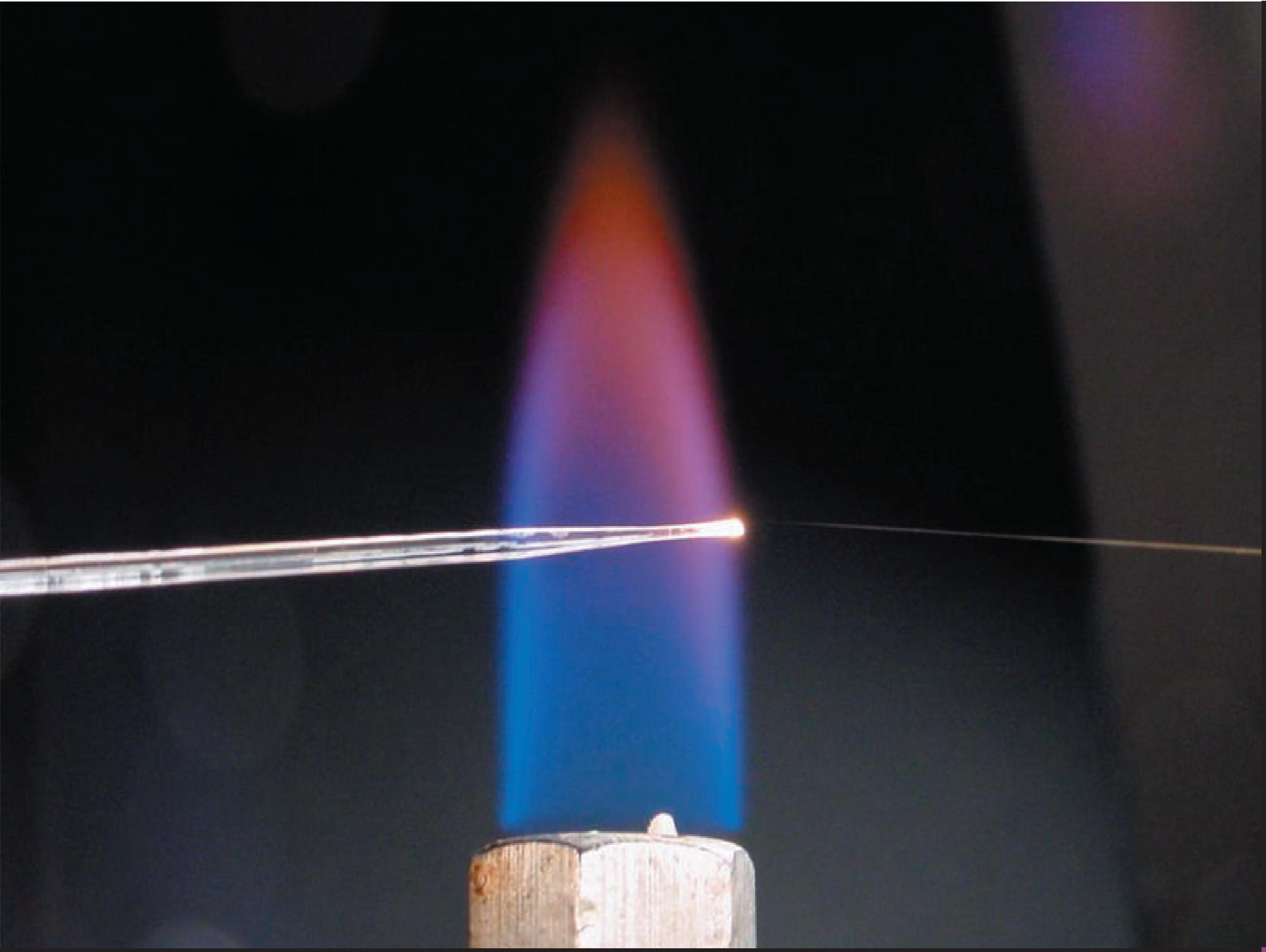

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More information:

http://mazur-www.harvard.edu