Engineering Expo 2009

Micro-Nano Sensors and Actuators Lab

Department of Electrical and Computer Engineering

University of Wisconsin, Madison WI

April 16-18th, 2009

Wetting and Thermal Wetting Switch

Wetting and Wettability

- **Wetting is the ability of a liquid to maintain contact with a solid surface. It results from intermolecular interactions .**
- **Wettability is used to determine the degree of wetting.**
- **The behavior of wetting depends on the natural properties of the liquid and the solid surface. For example, water tends to adhere with a glass surface, but tends to come off from a plastic surface.**

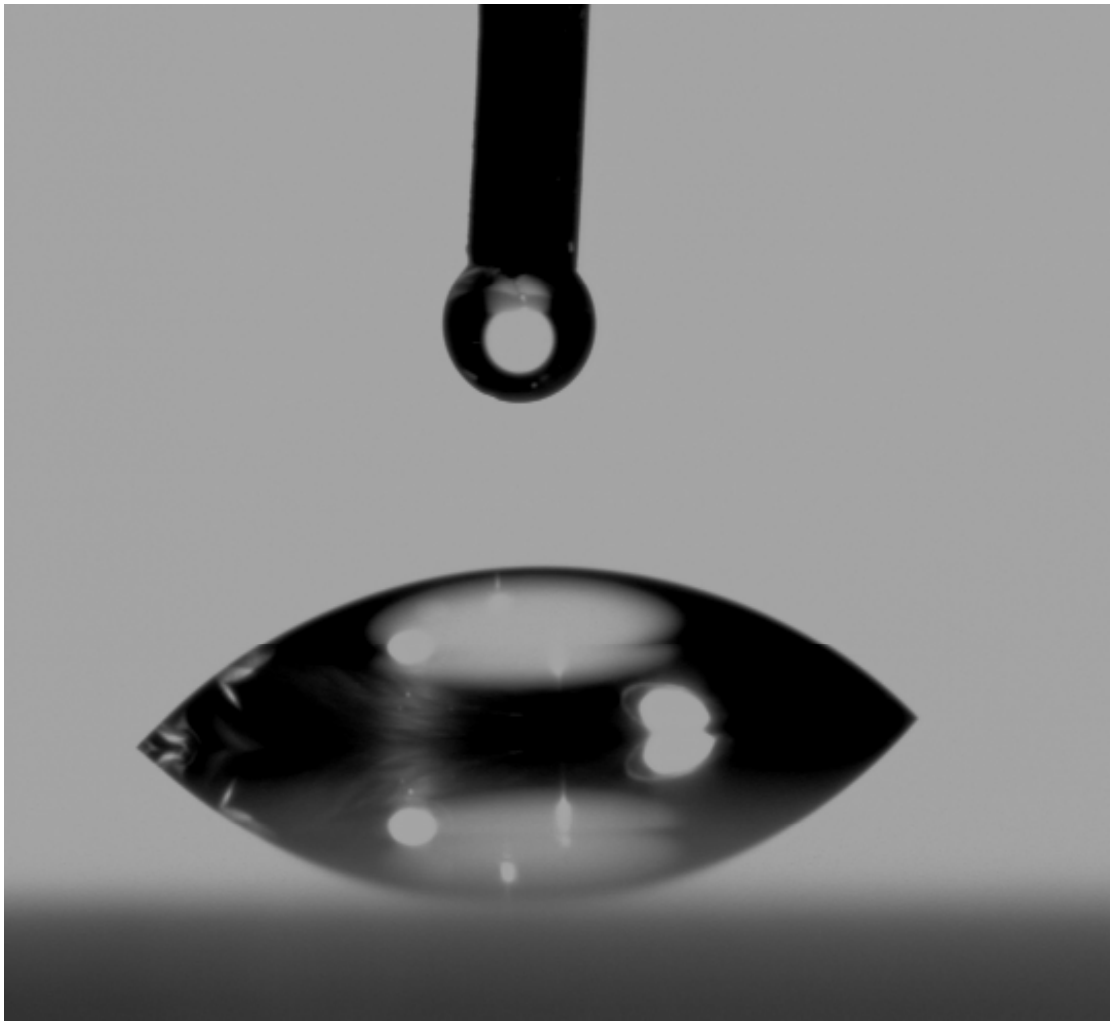


Figure 1: A water droplet on a glass surface.

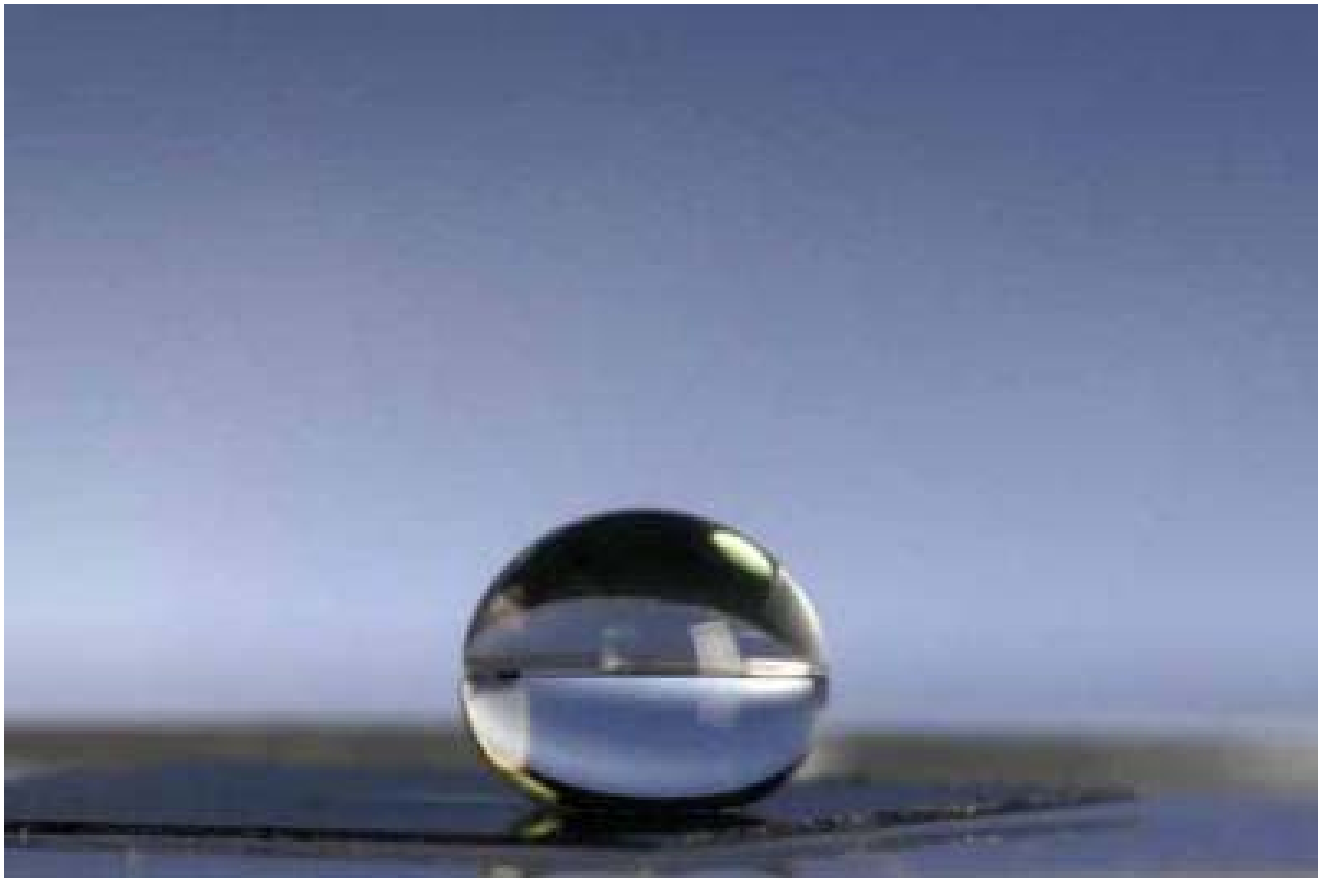


Figure 2: A water droplet on a plastic surface.

Source: Photo by Jo McCulty, courtesy of Ohio State University.

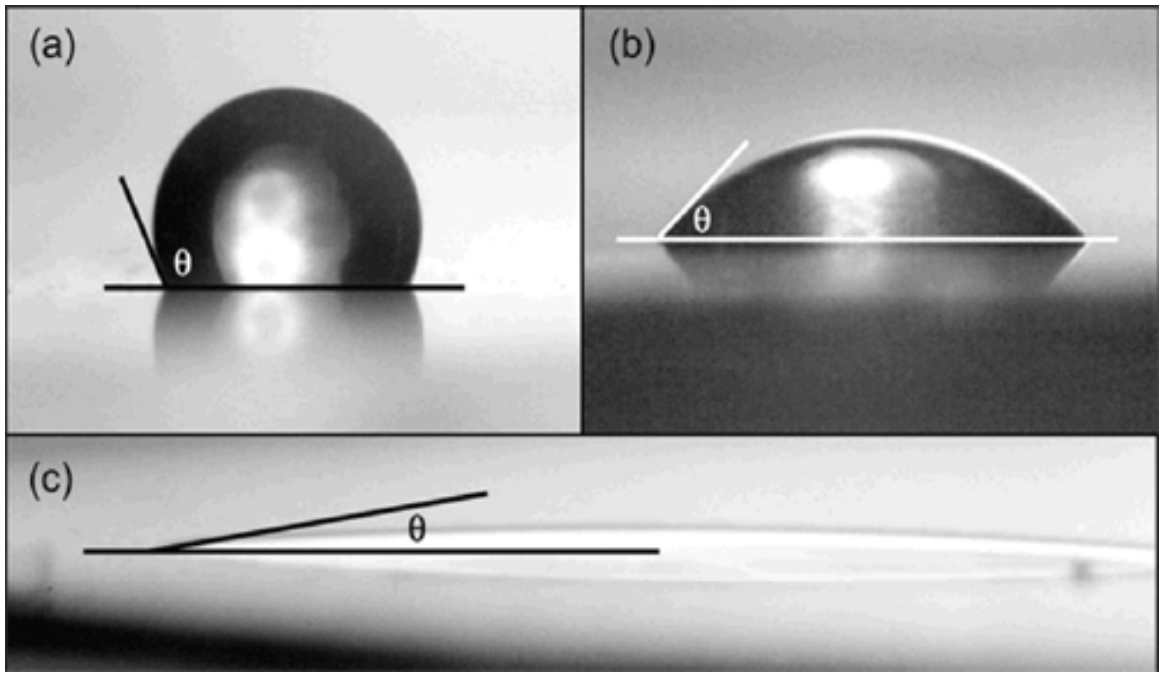


Figure 3: Water droplet contact angle measurements on 3 different borosilicate glass surfaces: (a) halocarbon wax-coated (92°), (b) untreated (32 ± 2°), and (c) argon plasma-cleaned using a Harrick Plasma cleaner (<10°).

Source: Sumner, A. L. et al., *Phys. Chem. Chem. Phys.* (2004) 6: 604-613.

Thermal Wetting Switch

- **Generating a layer of plastic-like material on a glass/ silicon surface will change the wetting properties.**

  The molecules in the plastic layer (composited by a material called "PNIPAAm") on the glass/silicon surface will change their shape when heated, so the wettability of water on the surface will change with temperature.

  (See Videos for it!)

Applications of the Wetting Switch

The samples with “PNIPAAm” modified surface can be used for: A liquid lens which can change its shape (thus, its focal-length) with temperature!

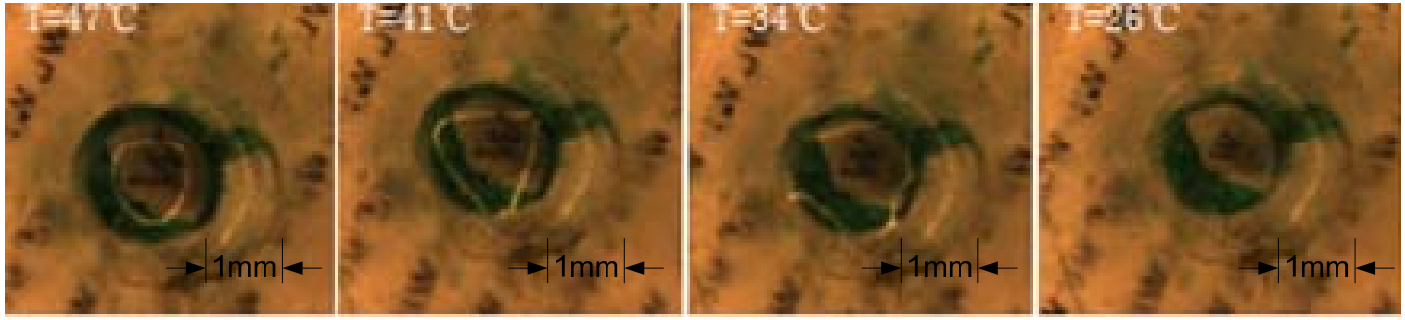
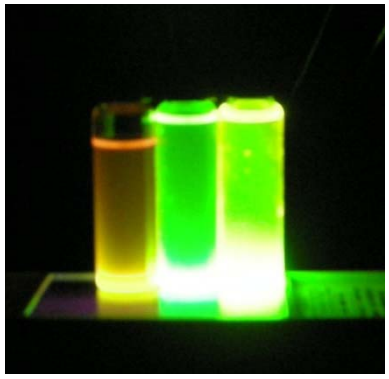


Figure 4. *Image of the lens device at different temperatures. The size of the refracted letter “W” indicates the focal-length change.*

Quantum Dots (QDs)

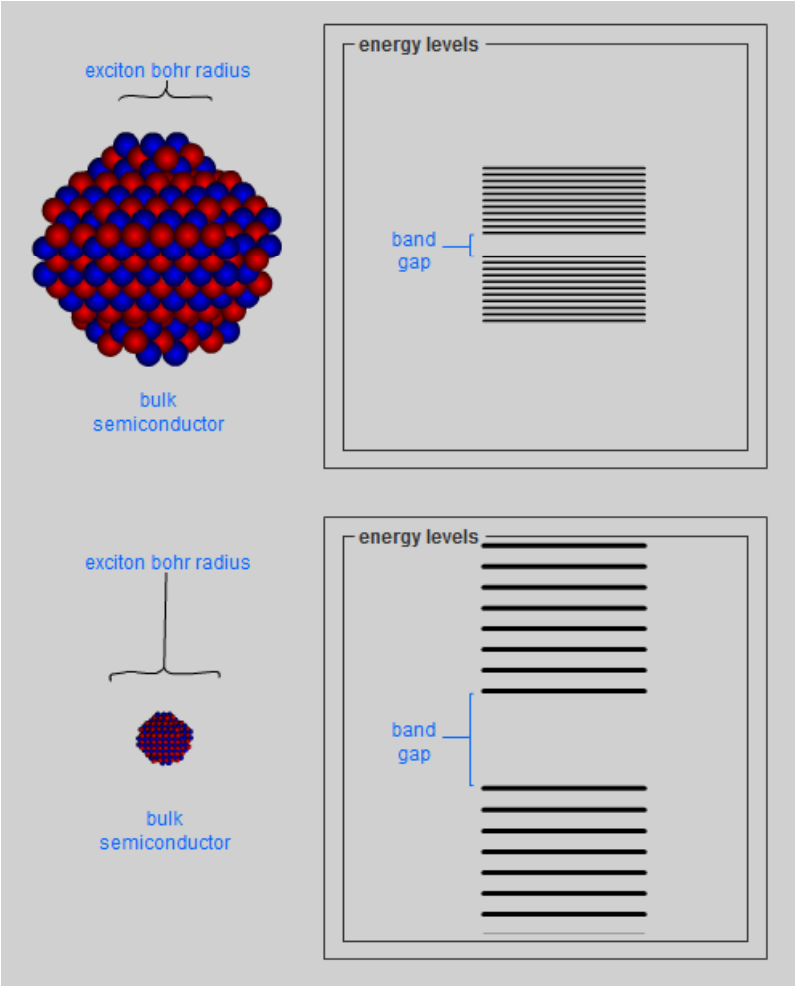
Introduction of Quantum Dots (QDs)

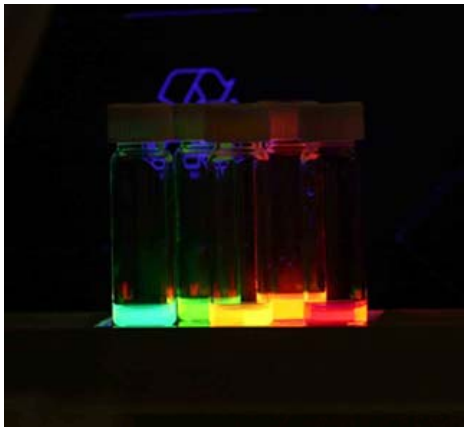
- Quantum dots, also known as nanocrystals, are a special class of materials known as semiconductors.
- Excitons have an average physical separation between the electron and hole, referred to as the Exciton Bohr Radius.
- The size of a QD becomes small enough that it approaches the size of the material's Exciton Bohr Radius, then the electron energy levels can no longer be treated as continuous.



As-produced CdSe QDs with different sizes irridiated by UV-light

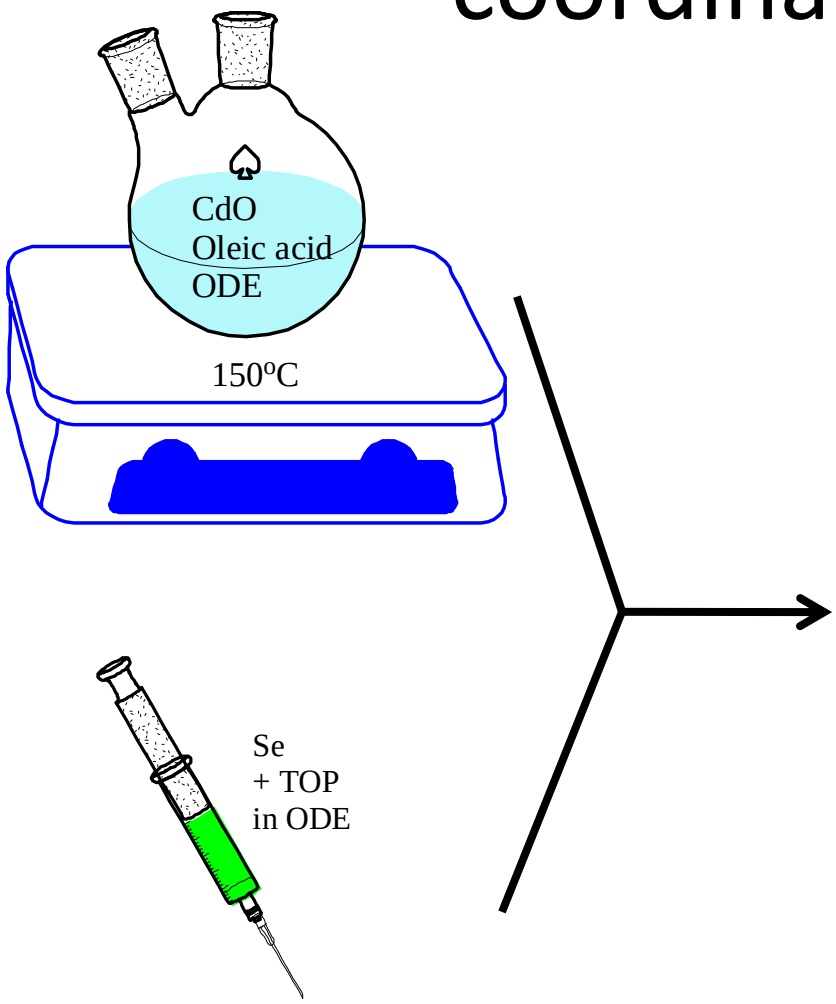
Introduction of Quantum Dots (QDs)



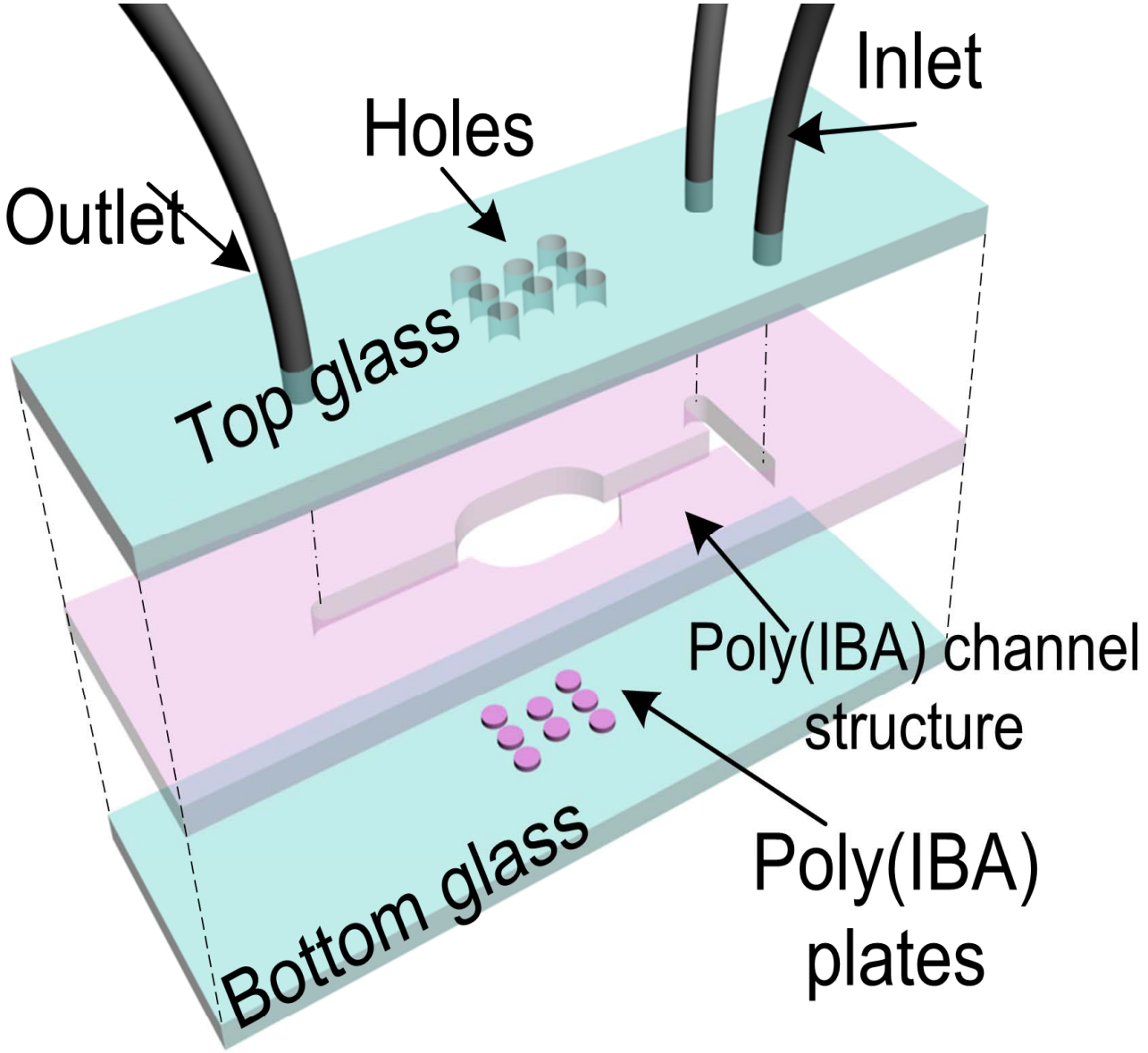


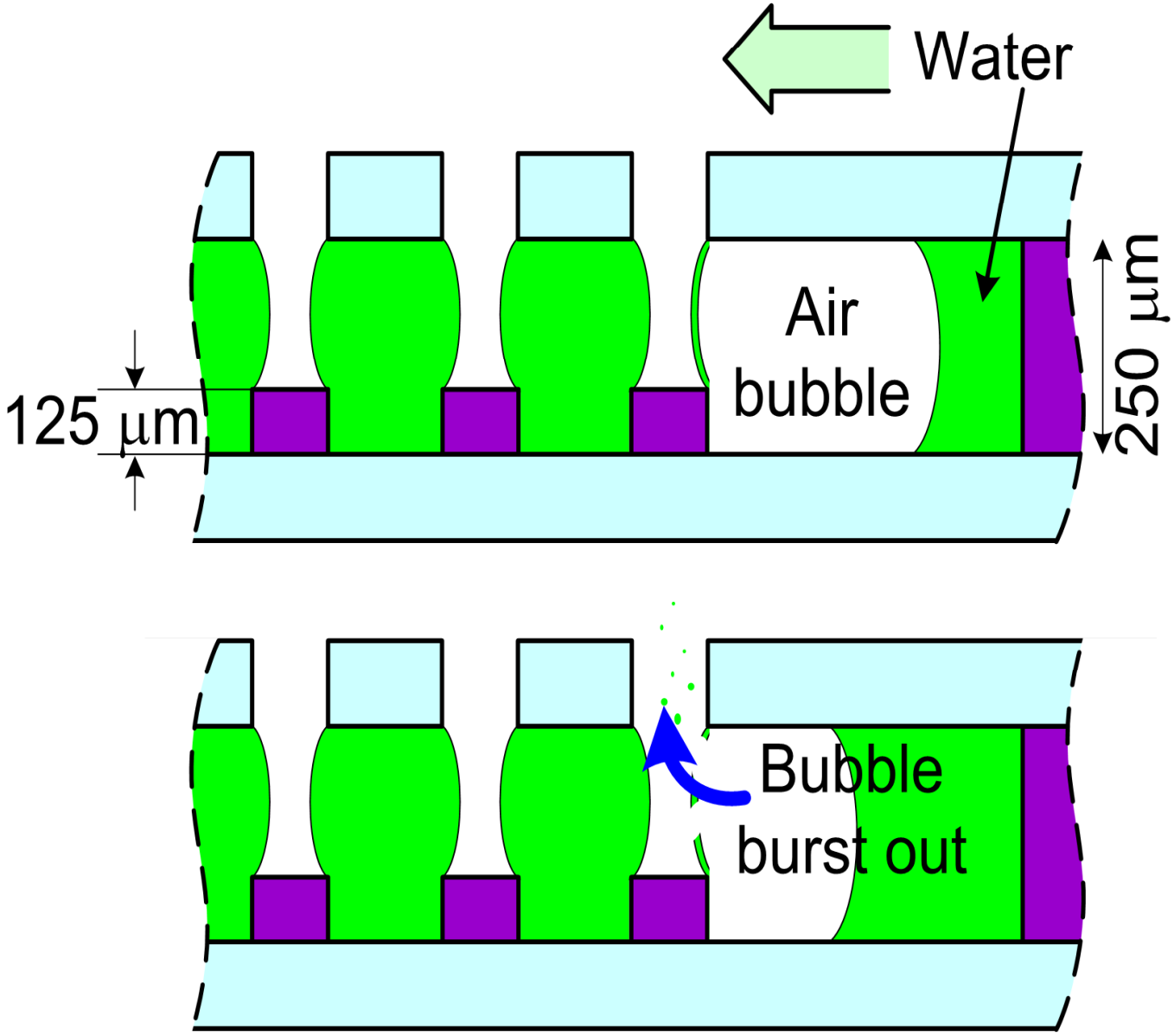
QDs irradiated with a UV light. Different sized quantum dots emit different color light due to quantum confinement.

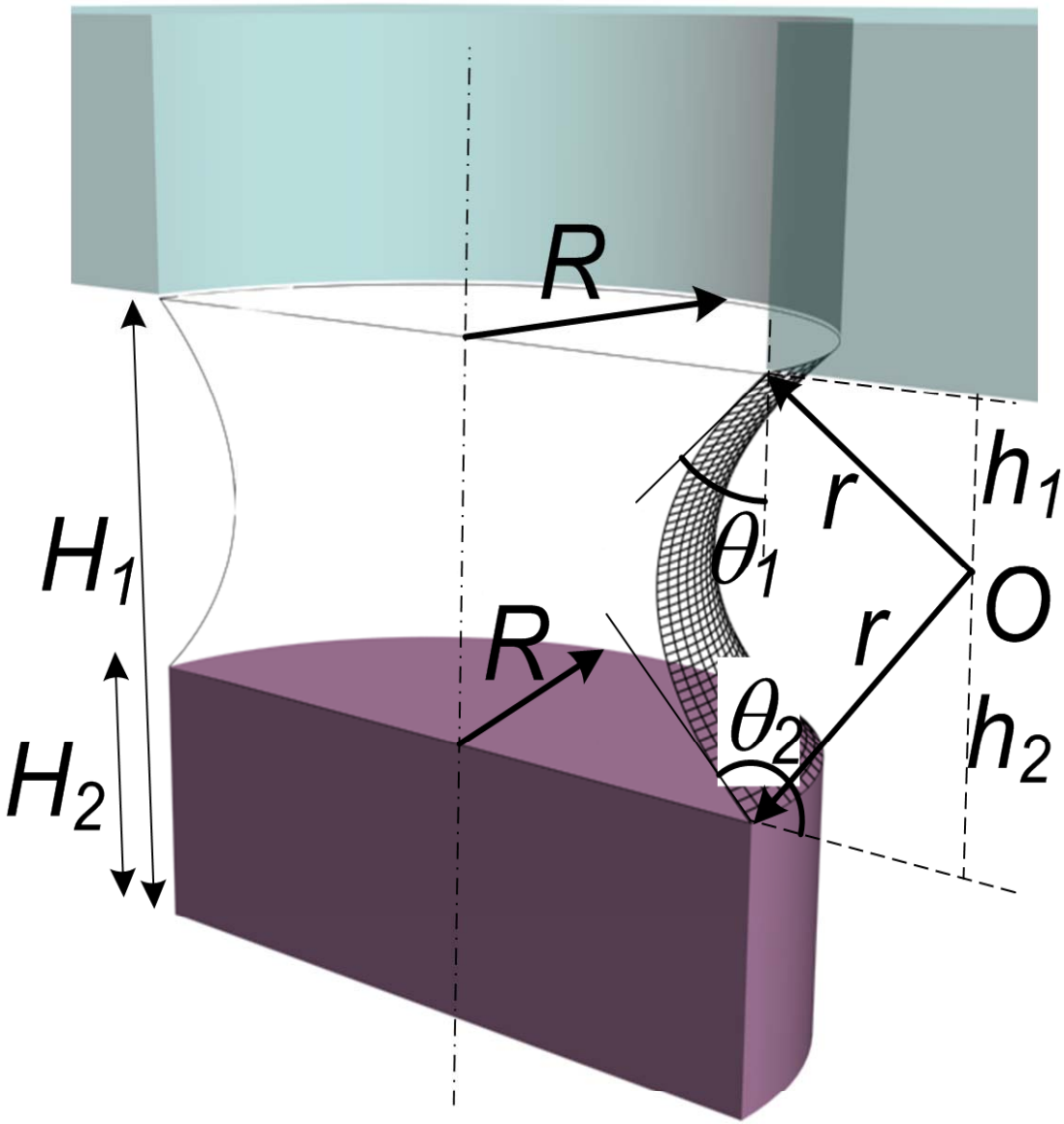
Synthesis of CdSe QDs in Non-coordinating solvent

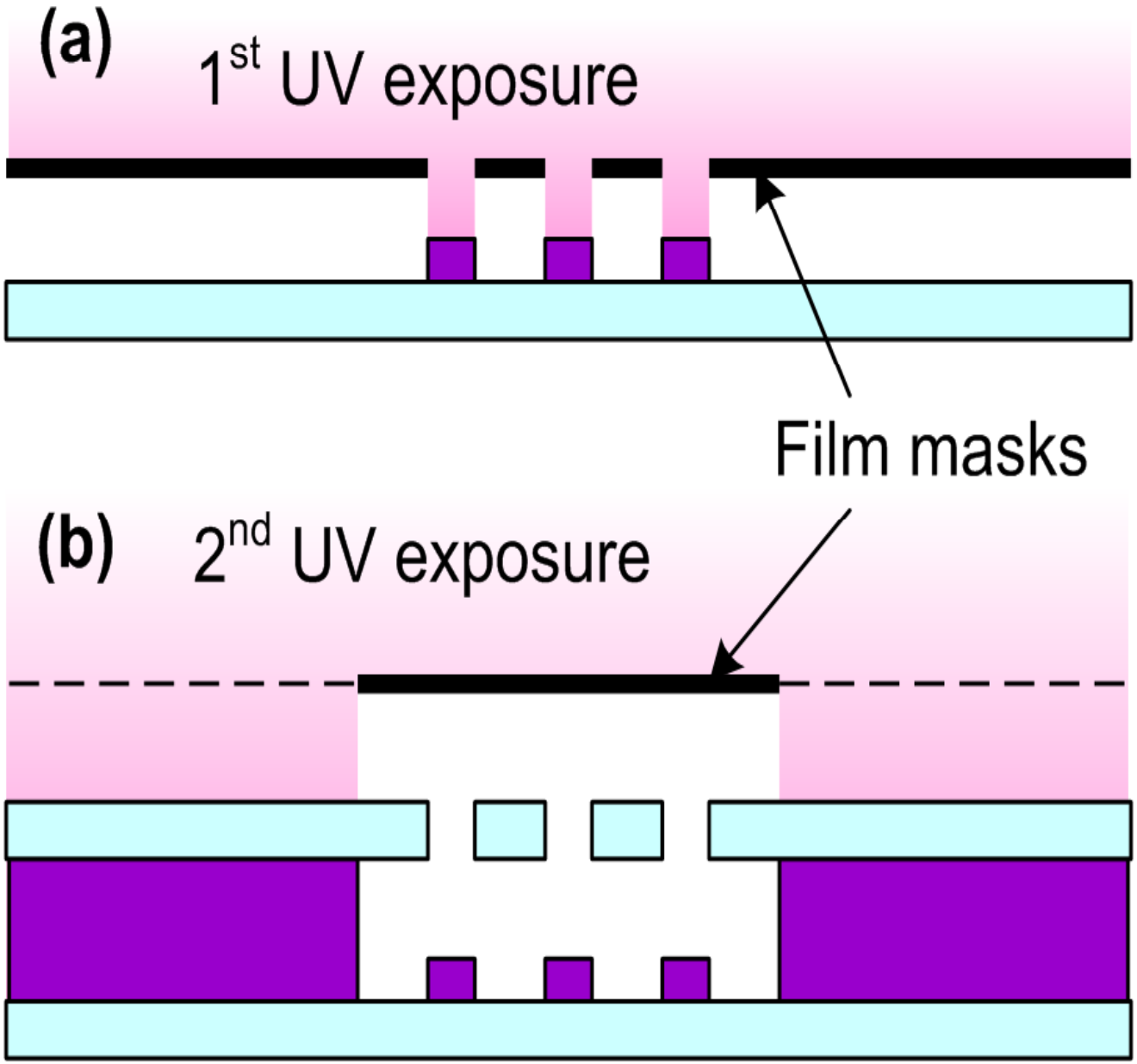


Debubbler


Inlet
Holes
Outlet
Top glass
Poly(IBA) channel structure
Poly(IBA) plates
Bottom glass


Water
Air
bubble
125 μm
250 μm
Bubble
burst out


R
H1
H2
R
r
θ1
h1
O
r
θ2
h2


(a)
1st UV exposure
Film masks
(b)
2nd UV exposure