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Synthesis Routes for Large Volumes of Nanoparticles

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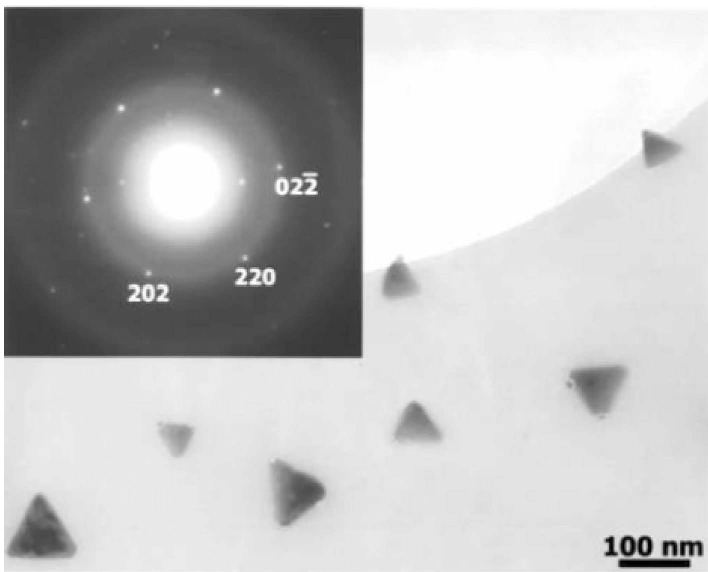
Metals, chalcogenides, main group elements, oxides, pnictides.

Semiconductor nanoparticles

Reduction of Si halides: $SiCl_4$ and $RSiCl_3$ (R = H, octyl) by sodium metal in a nonpolar organic solvent at high temperatures (385°C) and high pressures (>100 atm) to yield R-capped, hexagonal-shaped silicon nanoparticles.

J. R. Heath, A liquid-solution-phase synthesis of crystalline silicon. *Science* **258** (1992) 1131–1133

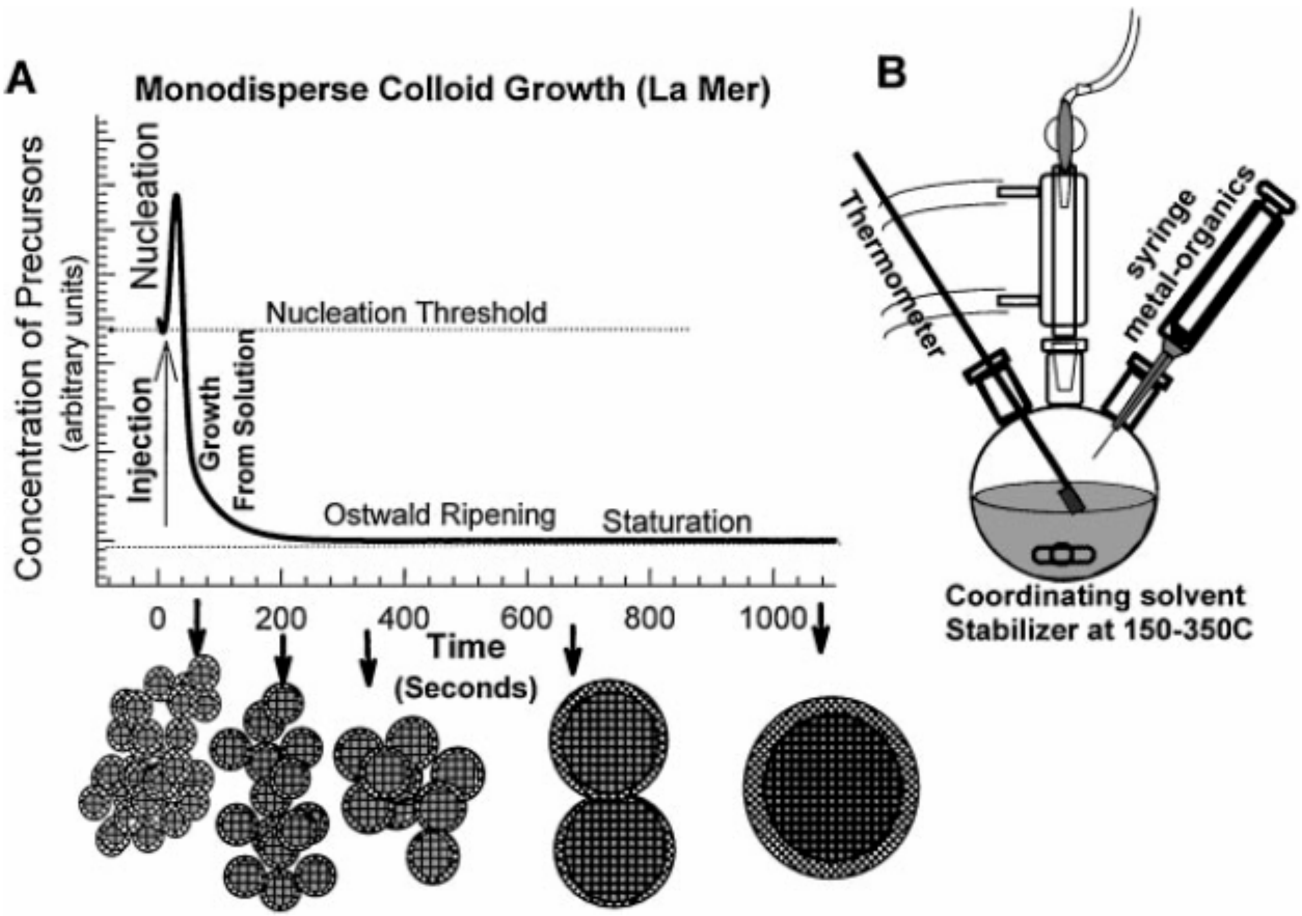


R. K. Baldwin, K. A. Pettigrew, J. C. Garno, P. P. Power, G. Y. Liu, and S. M. Kauzlarich, Room temperature solution synthesis of alkyl-capped tetrahedral shaped silicon nanocrystals. *J. Am. Chem. Soc.* **124** (1992) 1150–1151.

Methathesis (Kauzlarich): anionic and cationic carbon group moieties;

$Mg_2Si + SiCl_4 \rightarrow 2MgCl_2 + 2Si$

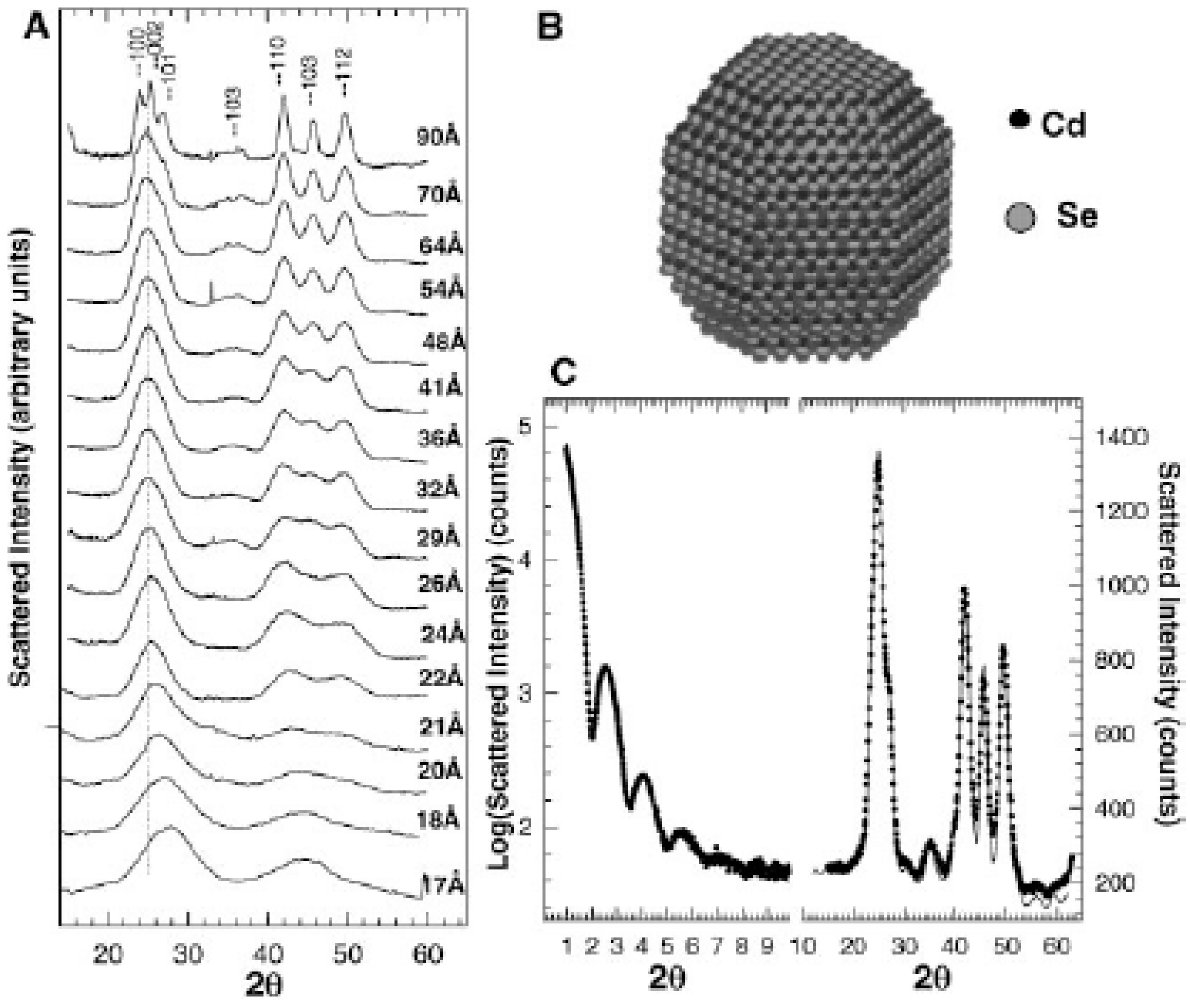
Semiconductor nanoparticles



$(CH_3)_2Cd$ + TOPSe in TOPO solvent; TOPse made from TOP + Se

C. B. Murray, C. A. Kagan, and M. G. Bawendi, *Annu. Rev. Mater. Sci.* **30** (2000) 545–610.

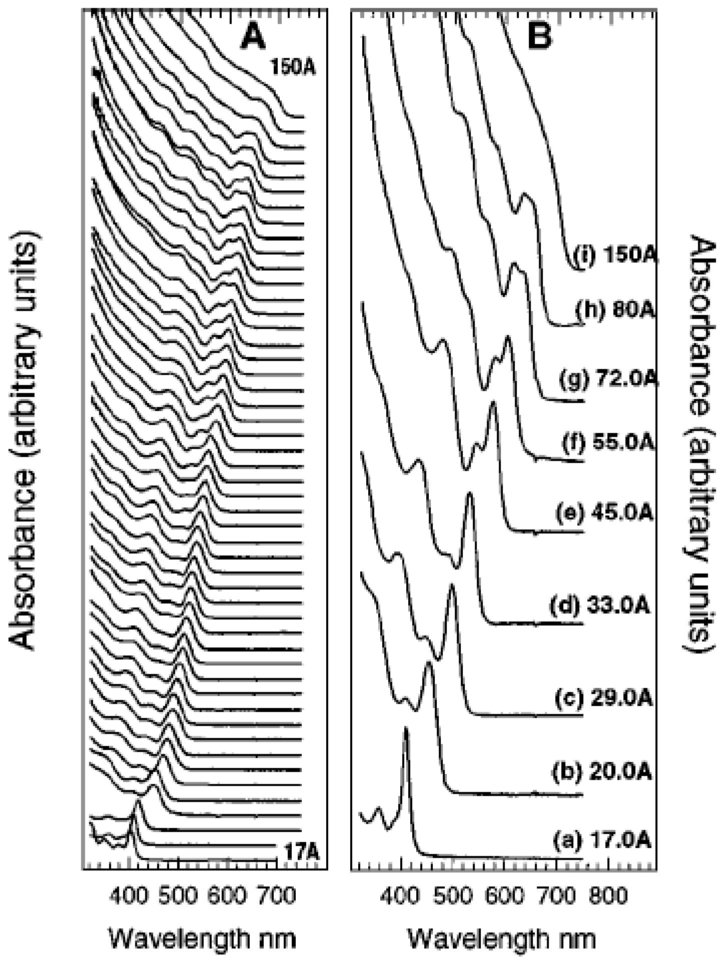
Semiconductor nanoparticles



CdSe nanoparticles of different sizes. On the right is a simulation using the Debye formula for real-space scattering.

C. B. Murray, C. A. Kagan, and M. G. Bawendi, *Annu. Rev. Mater. Sci.* **30** (2000) 545–610.

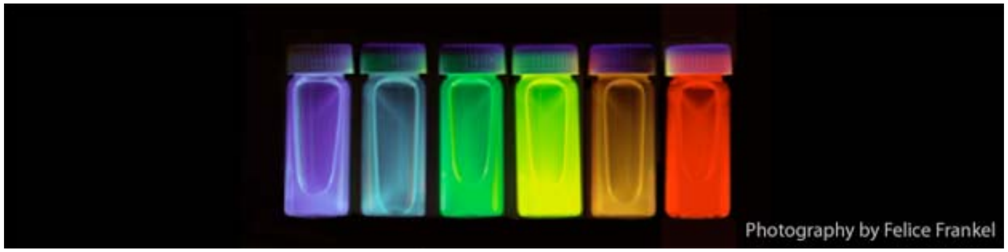
Semiconductor nanoparticles



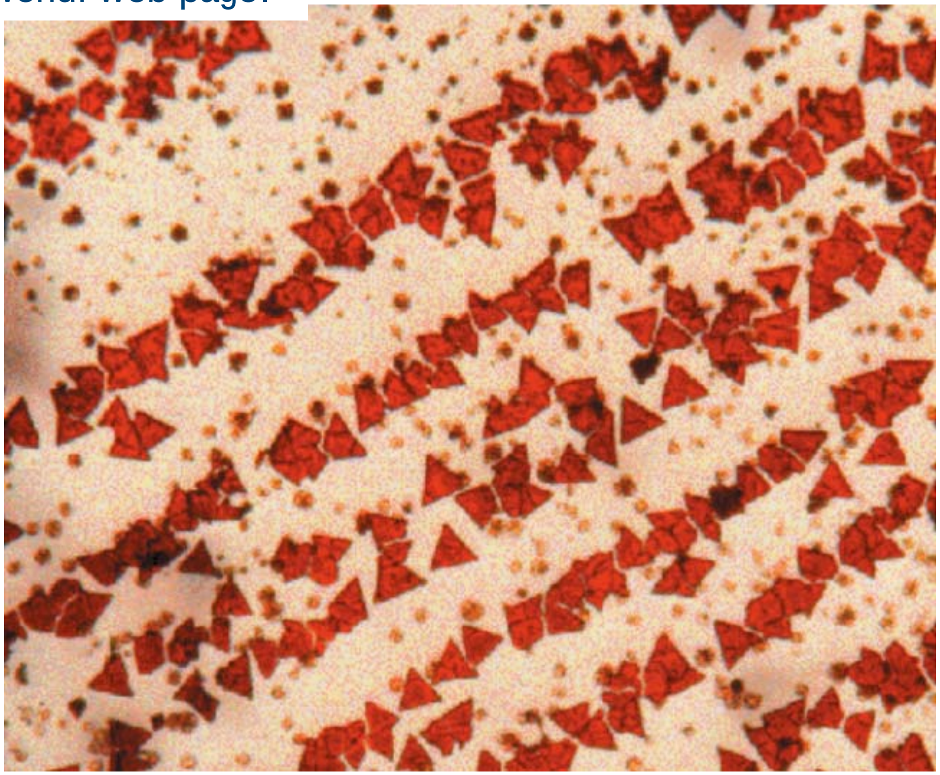
CdSe nanoparticles of different sizes showing size-dependent optical properties.

C. B. Murray, C. A. Kagan, and M. G. Bawendi, *Annu. Rev. Mater. Sci.* **30** (2000) 545–610.

Semiconductor nanoparticles



Nanoparticles in hexane, from the Bawendi web page.

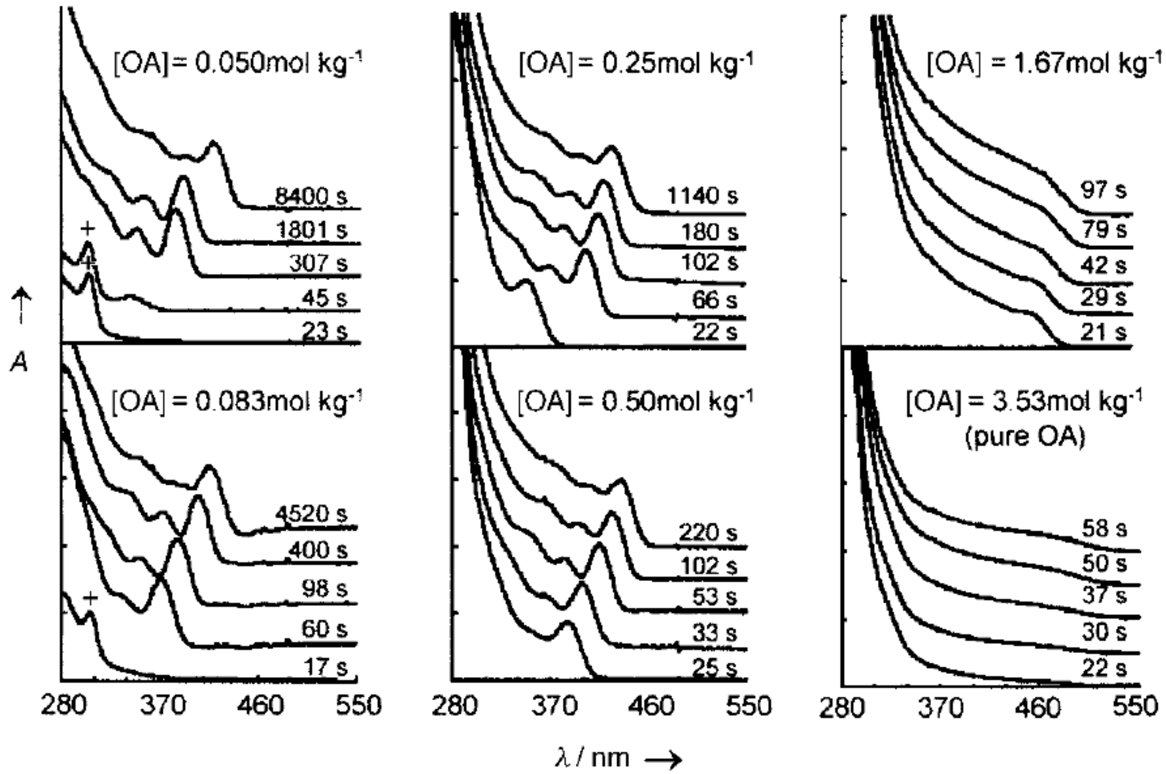


C. B. Murray, C. A. Kagan, and M. G. Bawendi, *Annu. Rev. Mater. Sci.* **30** (2000) 545–610.

Semiconductor nanoparticles

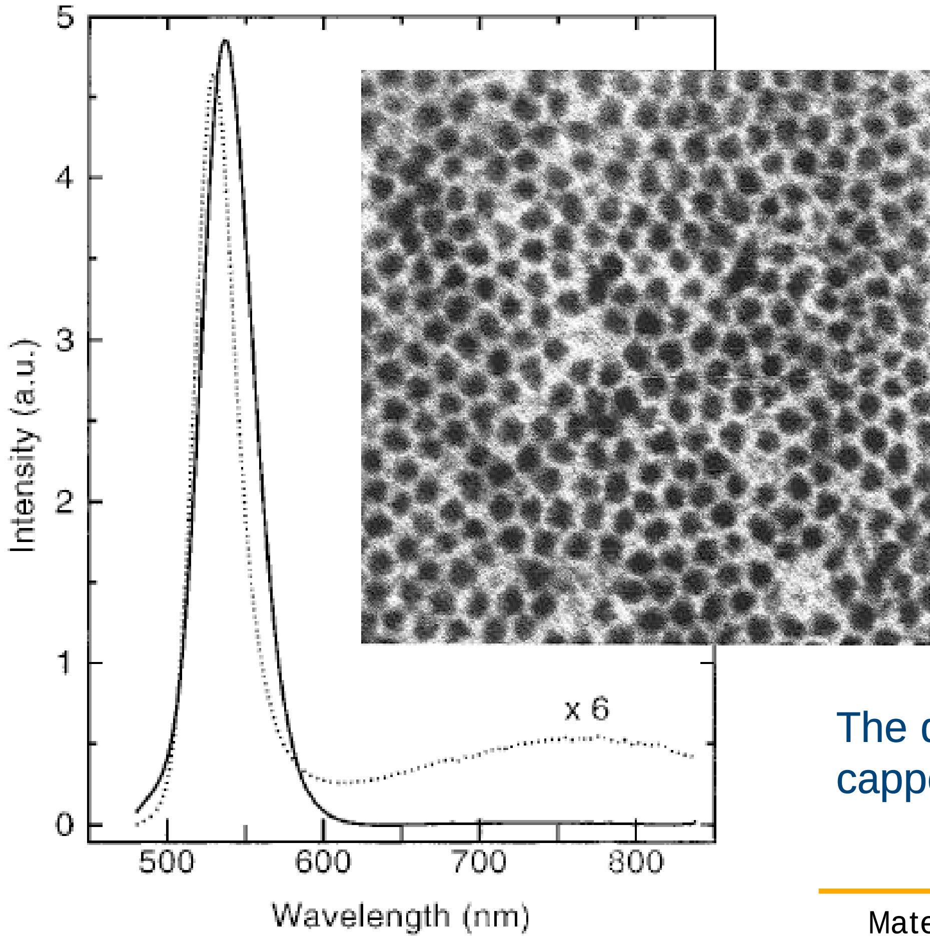
Improved preparations using CdO and S as starting materials. Wu and Peng, *Angew. Chem. Intl. Edn. Engl.* **41** (2002) 2368.

Use non-coordinating solvents (octadecene) and oleic acid as the capping agent.



Semiconductor nanoparticles

CdSe core/ZnSe shell nanoparticles. Hines and Guyot-Sionnest, *J. Phys. Chem.* **100** (1996) 468.
Much higher luminescence efficiencies because the surface is protected and so-called “surface traps: are removed.

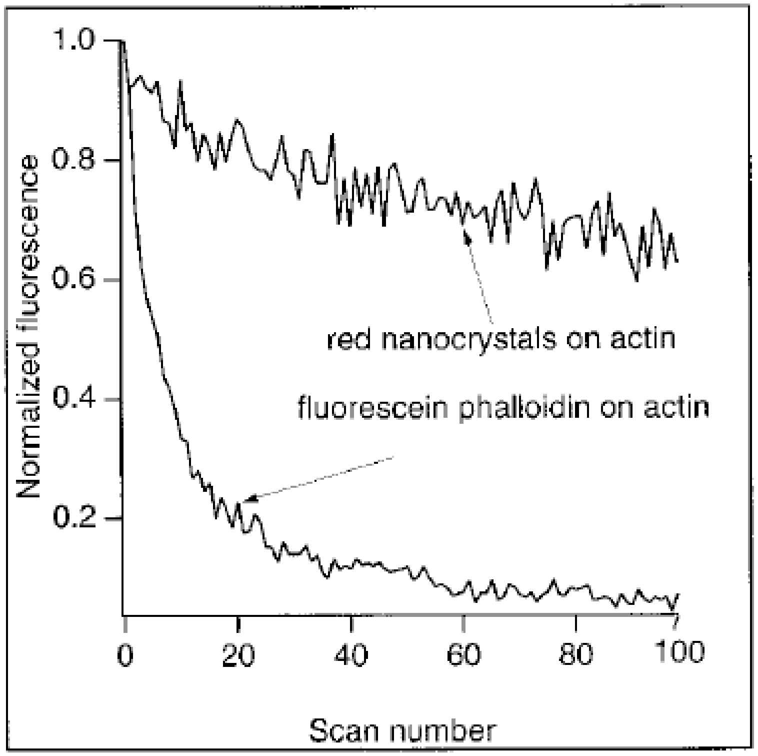


The dotted line is the luminescence from TOPO-capped CdSe.

Semiconductor nanoparticles

Bruchez, Morone, Gin, Weiss, Alivisatos, **281** (1998) 2013.

Nanocrystals as biological labels



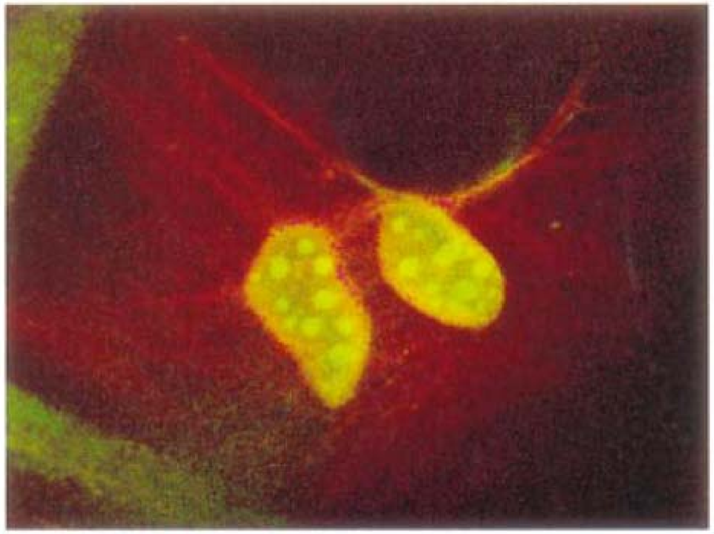


Fig. 3. Cross section of a dual-labeled sample examined with a Bio-Rad 1024 MRC laser-scanning confocal microscope with a 40× oil 1.3 numerical aperture objective. The mouse 3T3 fibroblasts were grown and prepared as described in (*27*). A false-colored image was obtained with 363-nm excitation, with simultaneous two-channel detection (522DF 35-nm FWHM narrow-pass filter for the green, and a 585-nm long-pass filter for the red). Image width: 84 μm.