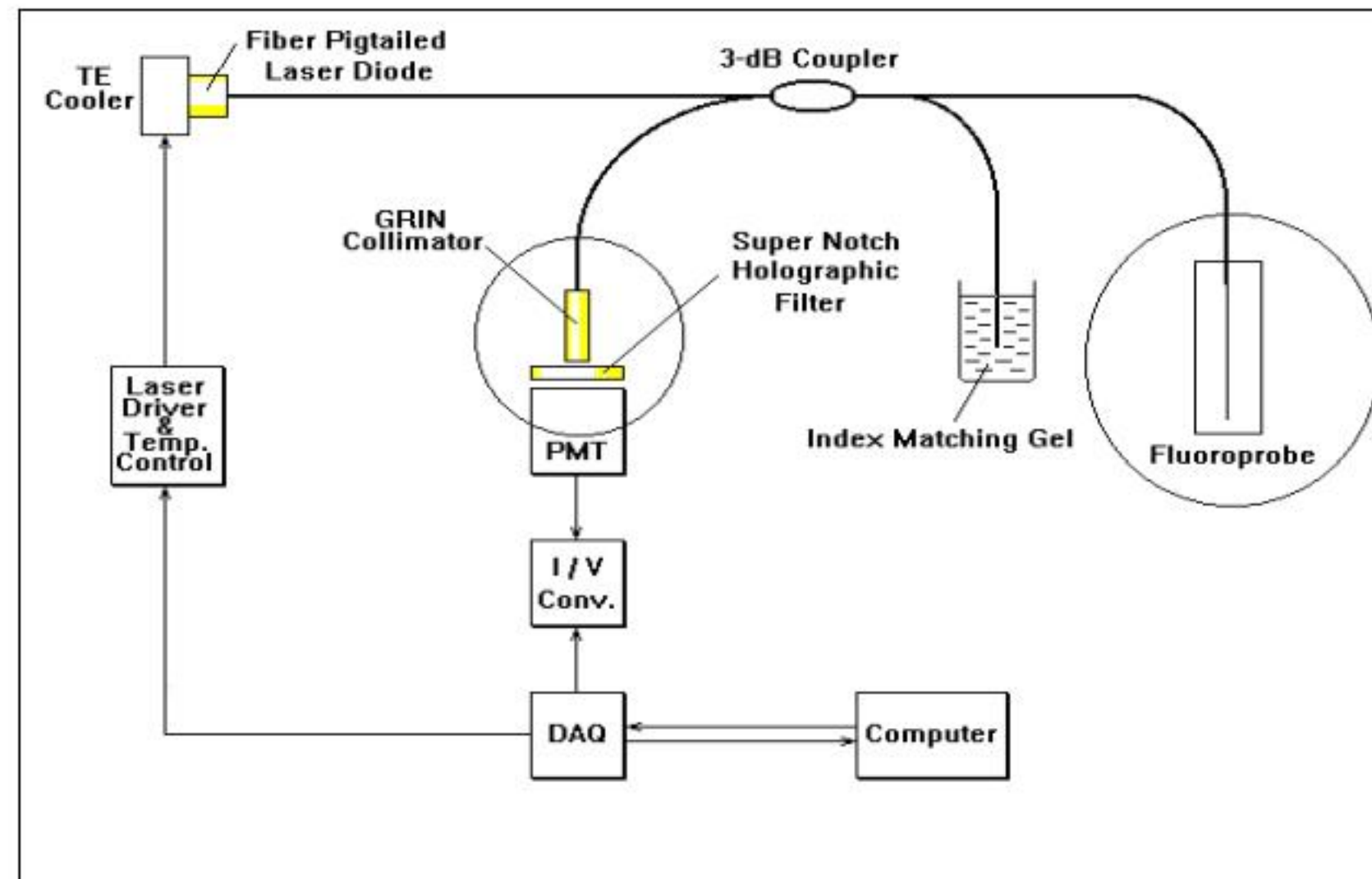


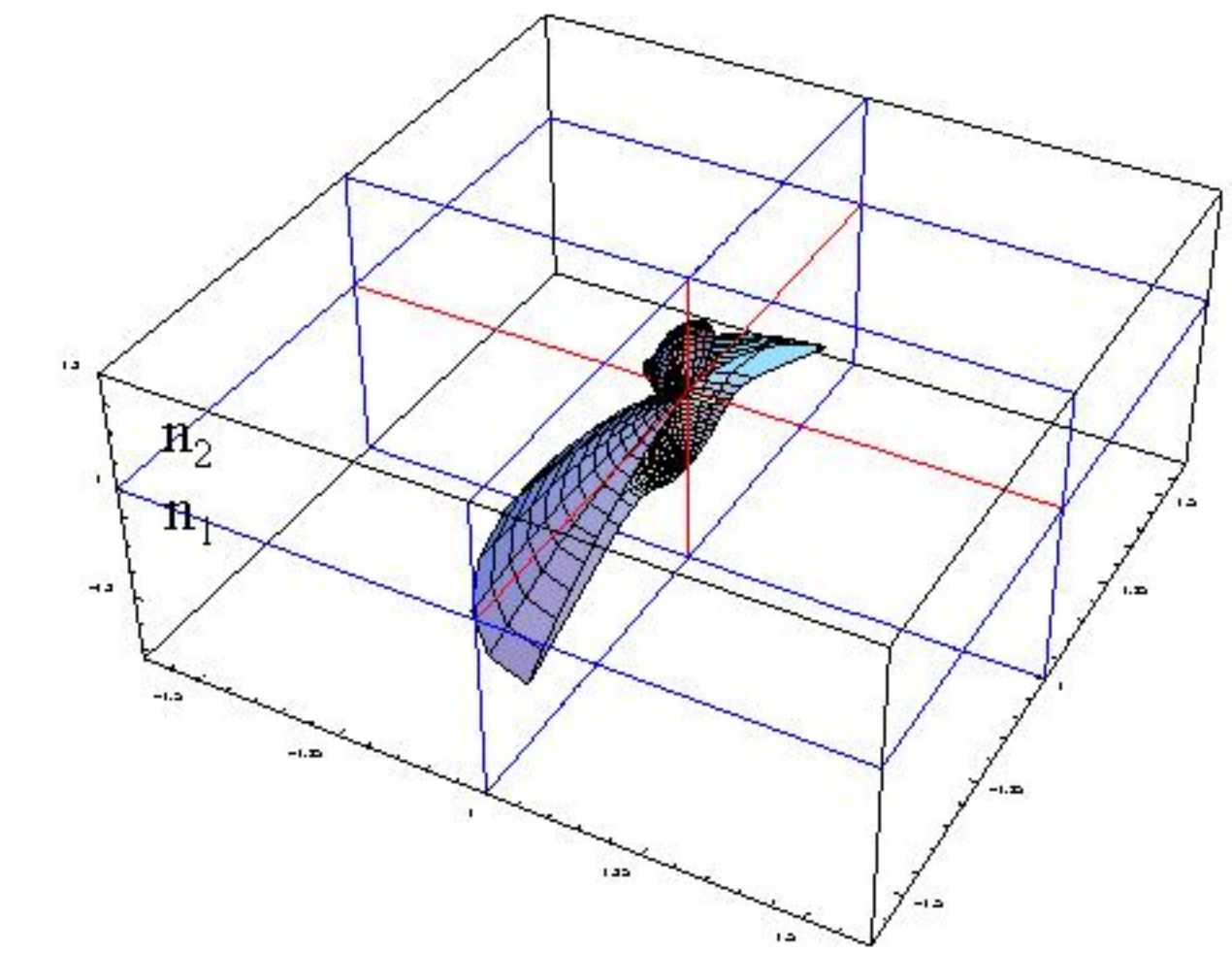
Optical Fiber Biosensors: Strong Anisotropy of Dipole Radiation at an Interface

Vildana Hodzic, *Hyunmin Yi, †James Sumner, † James B. Gillespie, *William Bentley, and Christopher C. Davis. Department of Electrical and Computer Engineering, *Department of Chemical Engineering, †Army Research Laboratory, Adelphi, MD

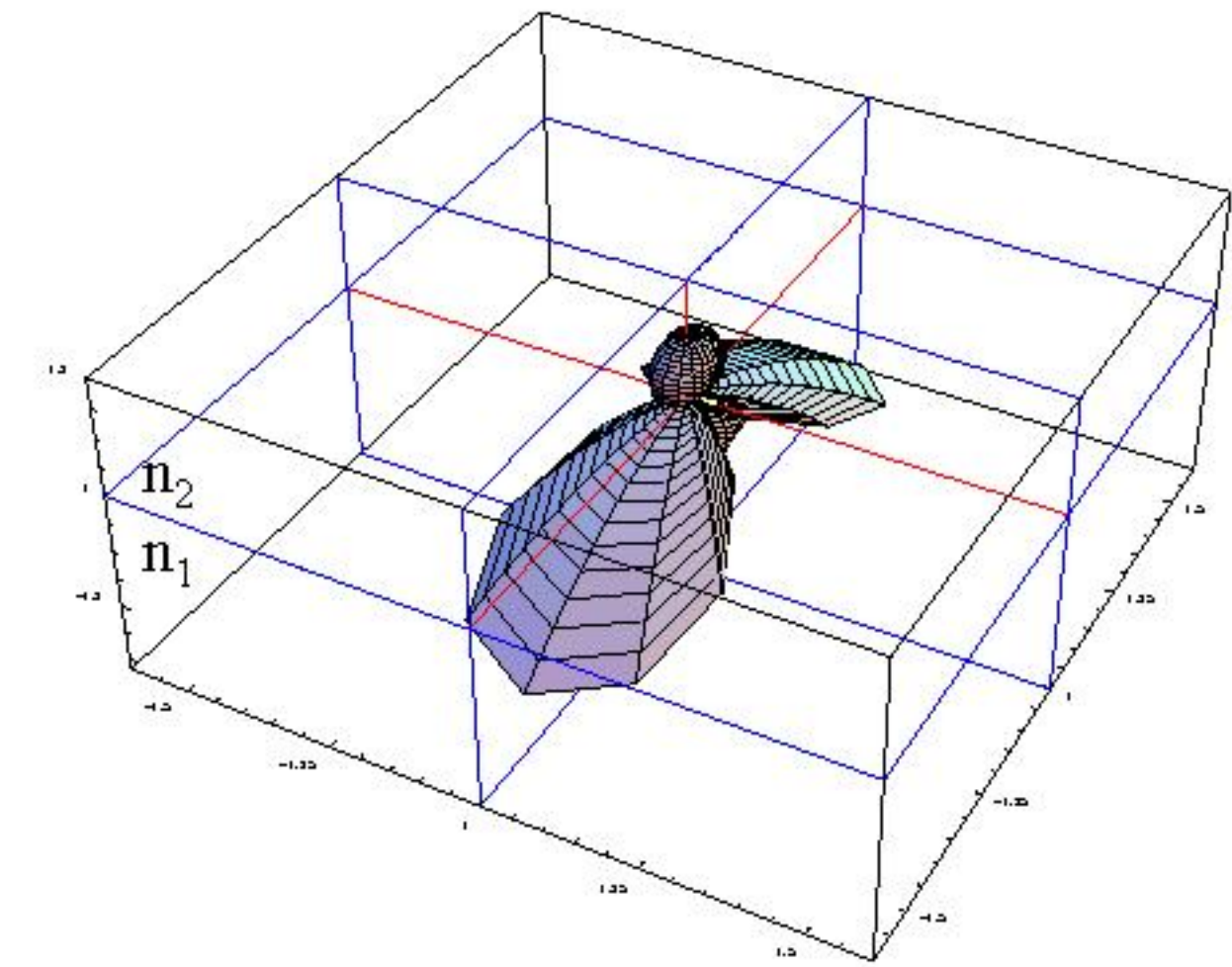


Schematic diagram of the optical fiber biosensor

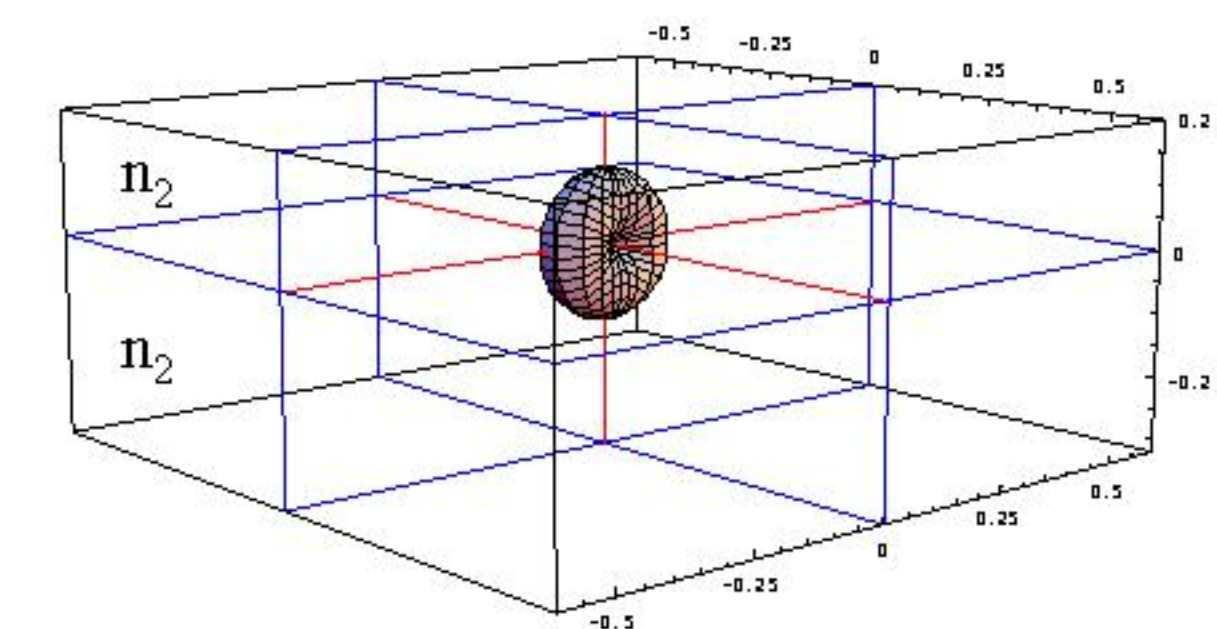
The presence of an interface near a fluorescing molecule introduces important changes into its radiation. A very important effect of the interface, which is relevant to optical fiber biosensor design, is a strong anisotropy of radiated intensity when the distance of the radiating dipole is small compared to the wavelength of dipole radiation. For molecules situated at a refractive-index discontinuity the emission maximum lies at the critical angle of the two media, and a significant part of the radiation is emitted at angles above the critical angle. A significant amount of the radiation emitted into a denser medium comes from modes that are evanescent on the rarer-medium side. The integrated radiation of a dipole at the interface is greater than that of a free dipole in unbounded medium 2 (with no interface). The physics behind this is shortening of the fluorescence lifetime of surface-bound fluorescent molecules, which is another important effect of the interface.



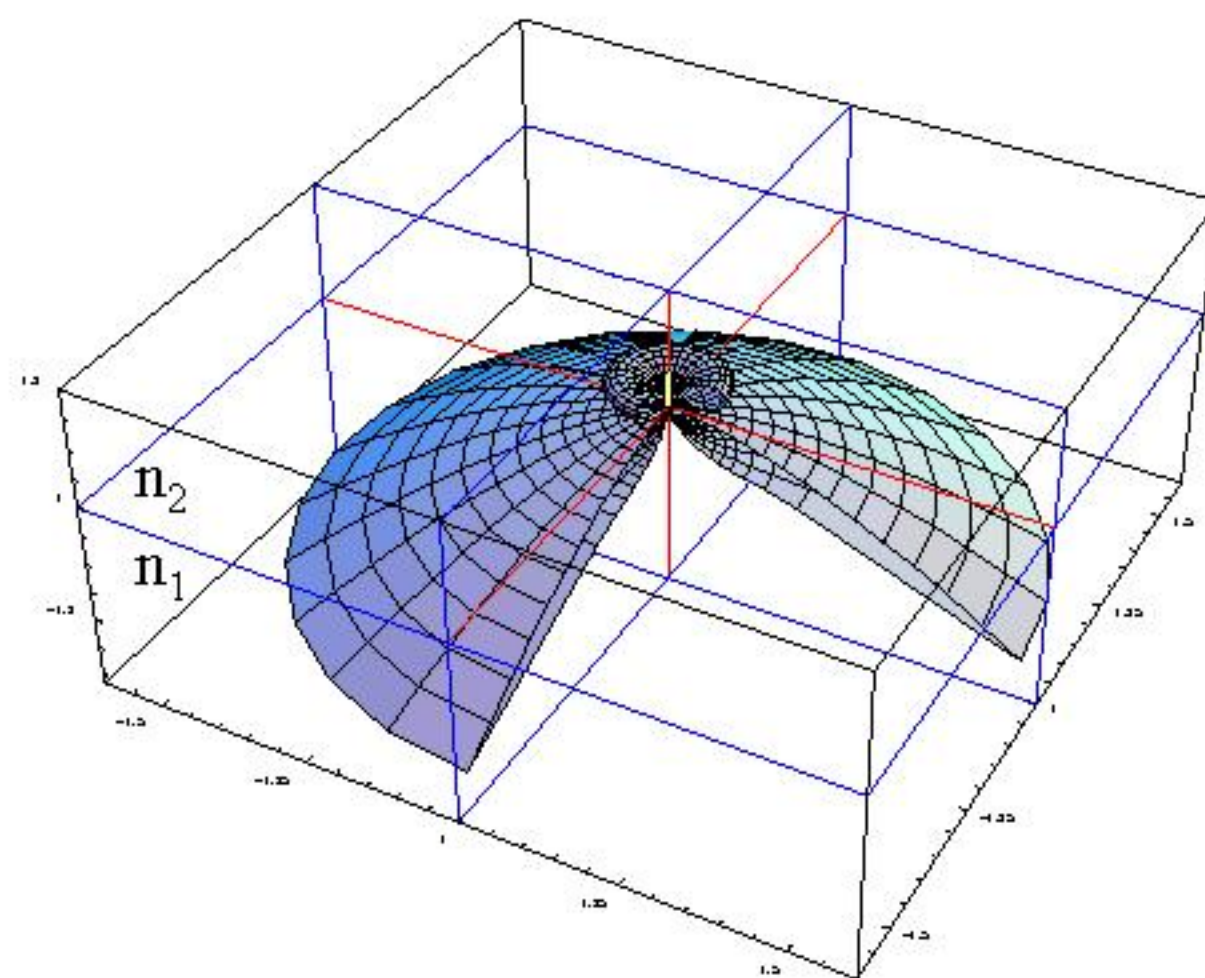
a)



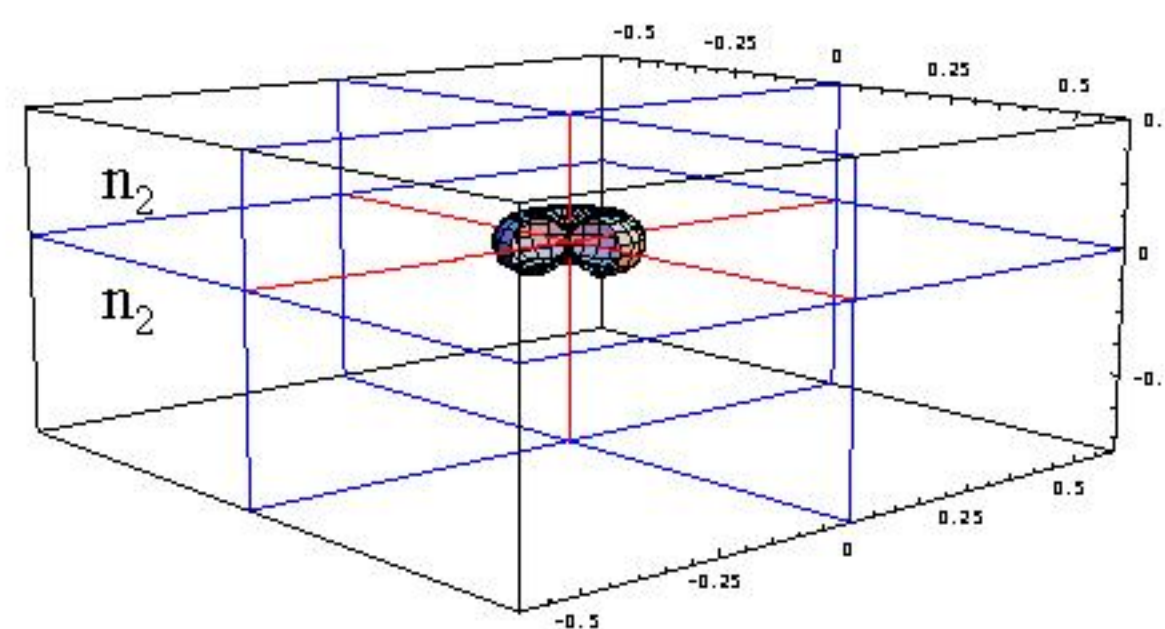
b)



c)

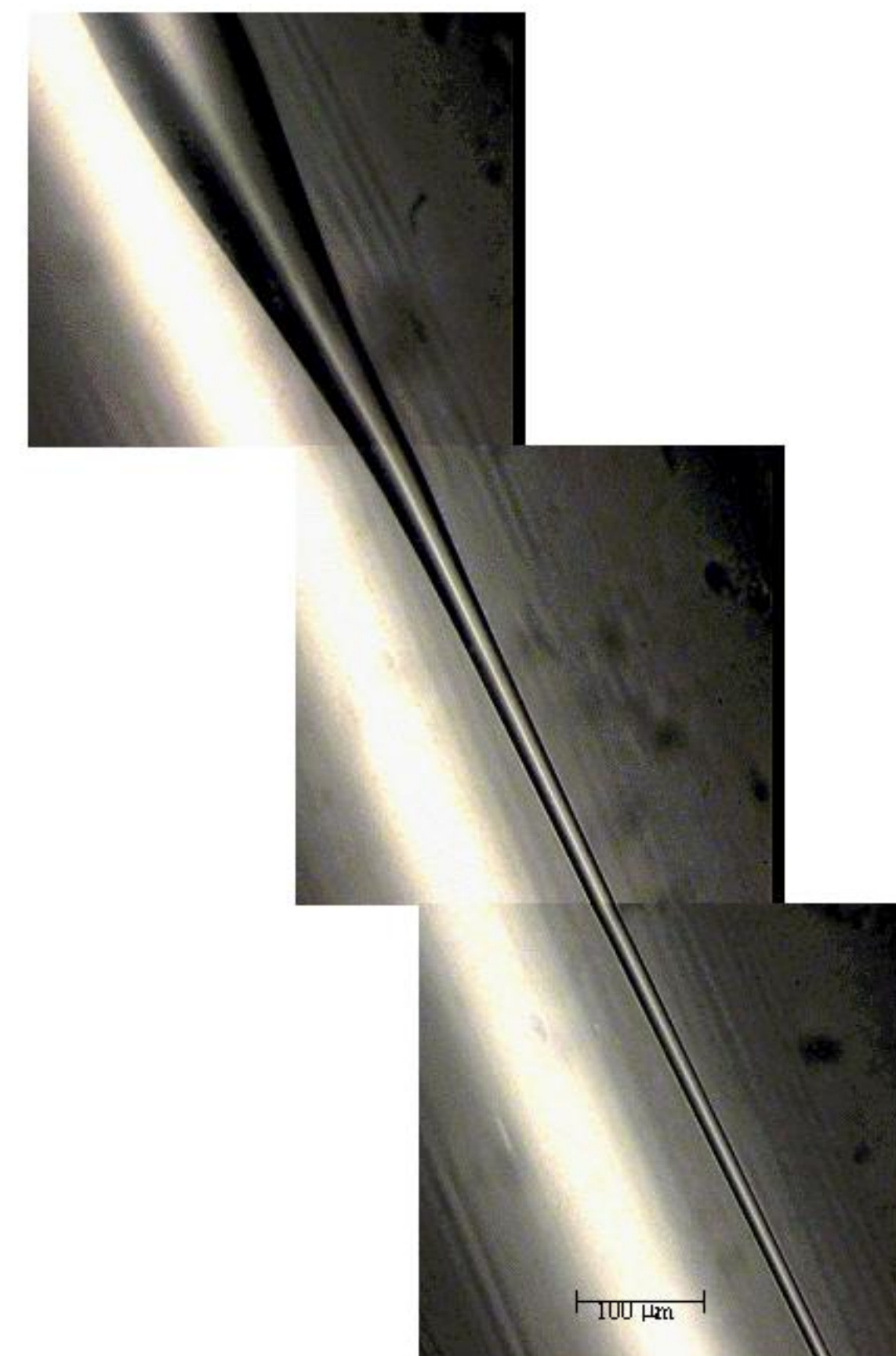


a)



b)

a) Angular distribution of radiated power of an electric dipole perpendicular (e, \perp) to the fused-silica/water interface ($n = n_1/n_2 = 1.0929$). Dipole is in water at a distance $z_0 = 0$ from the interface. b) Angular power distribution of a free dipole (e, \perp) in unbounded medium 2 (water).



Composite microscope picture of part of a tapered optical probe in a microcapillary tube. On this scale, the surrounding microcapillary is outside the field of view.

a) Angular distribution of radiated power of an electric dipole parallel (e, \parallel) to the fused-silica/water interface ($n = n_1/n_2 = 1.0929$). Dipole is in water at a distance $z_0 = 0$ from the interface. Only one half of the space is shown. b) Same as a) but the whole space is shown. c) Angular power distribution for a free dipole (e, \parallel) in unbounded medium 2 (water).