

The meeting was combined with the Lester Wolfe Workshop in Laser Biomedicine, sponsored jointly by the MIT Spectroscopy Laboratory and the MGH Wellman Laboratories. The workshop explored the theme: Spectroscopy on the Surface: Emerging Biomedical Applications. Robert Silbey, MIT introduced the topic by reviewing the history of Surface Enhanced Raman Spectroscopy (SERS) and providing an overview of the physics underlying the phenomenon. The effect was observed in fluorescence experiments in the 1965-1970 time frame; the fluorescence lifetime of dye molecules near a conducting surface was found to depend upon the distance from that surface. Later experiments by Van Duyne and others found that the Raman signal was enhanced under similar conditions. SERS could be understood using classical electromagnetic theory to model the interaction of an electric dipole with a nearby conducting surface. The modeling, which included both flat and curved metal surfaces, predicted SERS enhancements of 10^4 to 10^6 times, with further chemical effects such as charge transfer from adsorbed atoms providing additional enhancement of 10 to 100 times.

Richard VanDuyne, Northwestern University, then discussed to application of SERS to Nanoscale Optical Biosensors. The use of lithographic techniques allows the production of surfaces with closely-controlled structures which are useful both for providing reproducible effects and for investigating size and shape effects on enhancement. Experiments using transmission spectroscopy to study the properties of metallic nanoparticles on transmitting substrates showed the effect of surface plasmons; optical extinction peaks were observed over a wide spectral range, 400 to 6000 nm, the peaks being sensitive to both the size and the shape of the nanoparticles. Next, sensor applications were studied by binding biotin to silver nanostructures on glass substrates. When challenged by streptavidin, which binds to biotin, the structure showed changes in the optical extinction peak. Picomolar concentrations of bound compound could be detected. Envisioned applications include immunoassays and drug discovery. A microscoped-based optical system was developed to demonstrate single nanoparticle spectroscopy; the absorption spectrum of a particle, selected via the microscope, could be monitored as a function of binding.

Michael D. Morris, University of Michigan, spoke on "Skin and Bones: Raman and Surface Raman Microscopy in Dermatology and Orthopedics". A microprobe, consisting of a silver-coated iridium wire, was developed to measure sebum in the skin by SERS. The envisioned commercial application is to measure the depth distribution of sebum in skin after the use of different soaps. To date, a skin pore phantom has been made and the time course of a hydrolysis reaction monitored. Conventional Raman spectroscopy has been used to study bone, where SERS techniques are not applicable. A scanning Raman spectroscopy microscope has been constructed and used to study the mineralization of mouse calvarial sections as a function of time; phosphates and carbonates can be monitored. The system can be used to obtain surface mineral and proteins maps of bone. Finally, a panel discussion addressed the issue of why SERS effects are not more widely used. Among the reasons suggested were the need to obtain binding for a molecule of interest and the relatively recent application of nanotechnology to make tailored substrates with stable and reproducible properties.