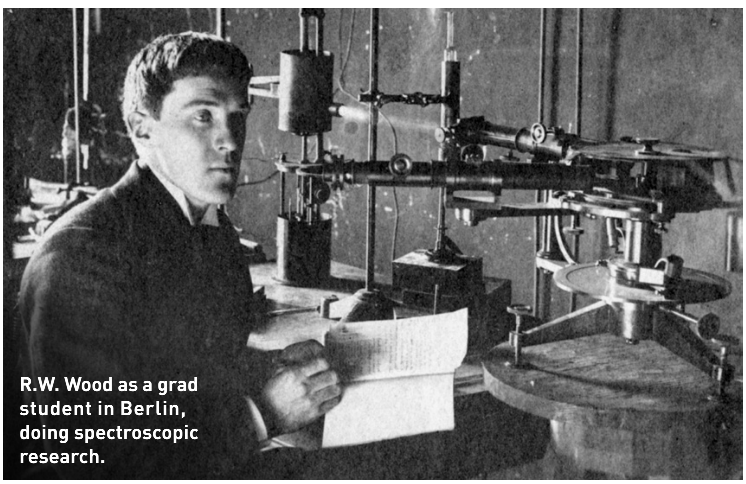
then

Surface Plasmon Resonance

An anomalous interaction between light and a metal surface, discovered in the early 20th century, was eventually harnessed for a hugely successful biosensor.

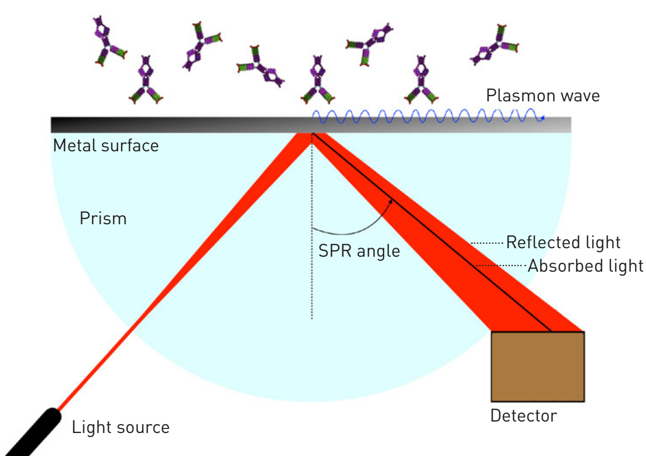


R.W. Wood as a grad student in Berlin, doing spectroscopic research.

AIP Emilio Segre Visual Archives

1902: A surface anomaly

The phenomenon of surface plasmon resonance (SPR) was first reported in 1902 by R.W. Wood when he observed an uneven distribution of light as it was reflected off a metal-backed diffraction grating. It took over 60 years for researchers to point out that surface plasma waves may be excited using attenuated total reflection—the concept for the classical SPR technique. This discovery inspired research on the confinement of optical fields near the surface of metals and the beginnings of nanoplasmonics.



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Cytiva

1983: Foray into biology

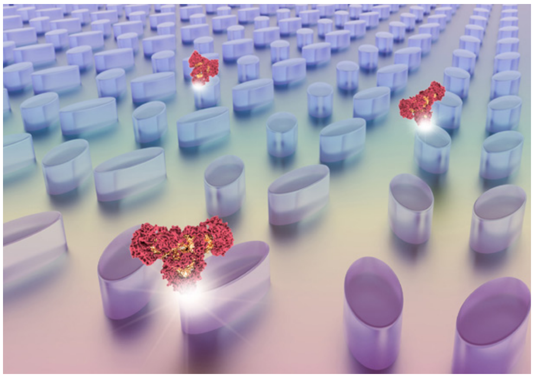
The use of SPR for biosensing purposes was first demonstrated in 1983 by three researchers at the Linköping Institute of Technology in Sweden. They demonstrated the first SPR immunoassay by adsorbing a protein onto a silver film and using the assay to detect its antibody in a solution. The relatively simple setup produced surprisingly sensitive results, which were calculated from the resonance angle shift, measured as an increase in the reflected light intensity, in response to the antibody concentration.

1990: From SPR to BIAcore

In 1990, Pharmacia launched BIAcore, the first commercial SPR instrument. The instrument represented the culmination of a cross-disciplinary effort between physics, engineering, chemistry and microbiology to create a sensitive, easy-to-use biosensing device. BIAcore used a convergent, LED-generated light beam together with a photodiode array to determine the SPR minimum position. The optical biosensor provided real-time biospecific interaction analysis—without using labeled molecules.

Nano and Plasmonic Biosensing

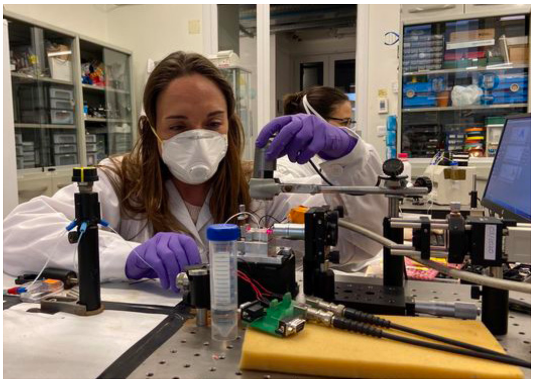
Advances in nanoplasmonics and nanophotonics are making photonic biosensors key enabling tools for an era of precision medicine.



EPFL / Bionanophotonic Systems laboratory

2019: A different kind of resonance

Taking advantage of dielectric metasurfaces, researchers in Australia and Switzerland have developed an ultrasensitive, label-free biosensing platform—one that detects biomolecules at a density of less than three molecules per square micron. The team's non-plasmonic dielectric nanoparticles avoid the loss of optical energy as heat, depending instead on resonances enabled by bound states in the continuum.



Courtesy of CONVAT

2020: Interferometry and more

Progress in nanofabrication and metamaterials has expanded the capabilities of biosensors. Silicon nanophotonic techniques can bump up sensitivity, for example, and lab-on-a-chip integration can provide clinical advantages. In Spain, a team is using nano-interferometric technology to develop a rapid, noninvasive corornavirus test—and the same biosensor has been explored as a cancer detector.

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2020: Detecting novel viruses

One research avenue being explored is the use of biosensors to detect bacteria and viruses in the air in real time. Researchers at ETH Zurich and EMPA in Switzerland have developed such an optical biosensor in response to the COVID-19 crisis. The sensor combines localized surface plasmon resonance (LSPR) with the plasmonic photothermal effect. The team demonstrated it by detecting a closely related coronavirus virus in a matter of minutes, although not yet in the air.

Personalized medicine and beyond

The holy grail of photonic biosensing is to be able to detect cancer in a single molecule, label-free. While we're not there yet, advances in nanotechnology continue to inch us closer to that goal. New diagnostic strategies, and even treatment methods, using this technology are also being explored. A recent wave of funding is also expanding research in photonic biosensors for COVID-19 diagnostics. Future development will also focus on integration into hand-held devices like smartphones for portable point-of-care systems.