Anthrax Detection in a Biocavity Laser

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Motivation—The anthrax bio-terrorism threat has become a reality. Innocent people have died by inhalation of anthrax spores sent via U. S. mail. A transduction method that could quickly detect anthrax spores would be a valuable tool in the fight against bio-terrorism. To this end, we devised a highly sensitive quantum optics transduction method using biocompatible laser microcavities to detect submicron pathogenic spores. The method uses recent advances in surface chemistry of semiconductor materials to create the microcavity.

Accomplishment—Anthrax spores and their simulants are very tiny particles, less than a micron in diameter, and nearly as small as the wavelength of light. Detection and analysis of these ultra-small particles requires new spectral-imaging techniques with high sensitivity. We used quantum squeezing of spontaneous light emitted through a spore flowing at high speed in a biocompatible semiconductor microcavity. This quantum squeezing allows even tiny spores to generate a whoppingly large spectral signal that can be easily detected. The spectral images (hyperspectra) are rapidly recorded and analyzed in a newly devised biolaser INCEPTOR (intracellular protein transduction by optical resonance) spectral imager/analyzer using efficient recognition software. This method extracts critical biological information from the lasing hyperspectra, including the protein coat morphology, intracellular granularity, spore shape and intracellular protein density and uniformity. The highly sensitive testing and differentiation of two common spore types, *B. subtilus* and *B. pumilus* that appear identical under the microscope, are shown in Fig. 1.

Significance—These data indicate that, with further development and testing, the biolaser INCEPTOR could rapidly identify different types of-anthrax spores, within a population of non-pathogenic spores. This analysis could be very useful for rapid, front-end screening of suspected pathogenic bacteria. The entire process, from set-up to diagnosis, could be completed in minutes. Such a field-deployable instrument is an attractive alternative to other, more time-consuming and labor-intensive DNA fragment analyses. Those analyses typically require restriction enzymes, PCR amplification, fluorescent tagging and cumbersome pulsed-field gel electrophoresis or specialized, expensive flow cytometry equipment. Further, the biolaser technique is compatible with immunofluorescence methods using molecular tags designed for anthrax antibodies. If intra-cavity surfaces are coated with an immunoassay antibody and the sample solution containing the conjugate antigen is flowed over the surface, the emitted light sensor will detect the interaction.

Sponsors for various phases of this work include: DOE Office of Basic Energy Sciences and Laboratory Directed Research & Development
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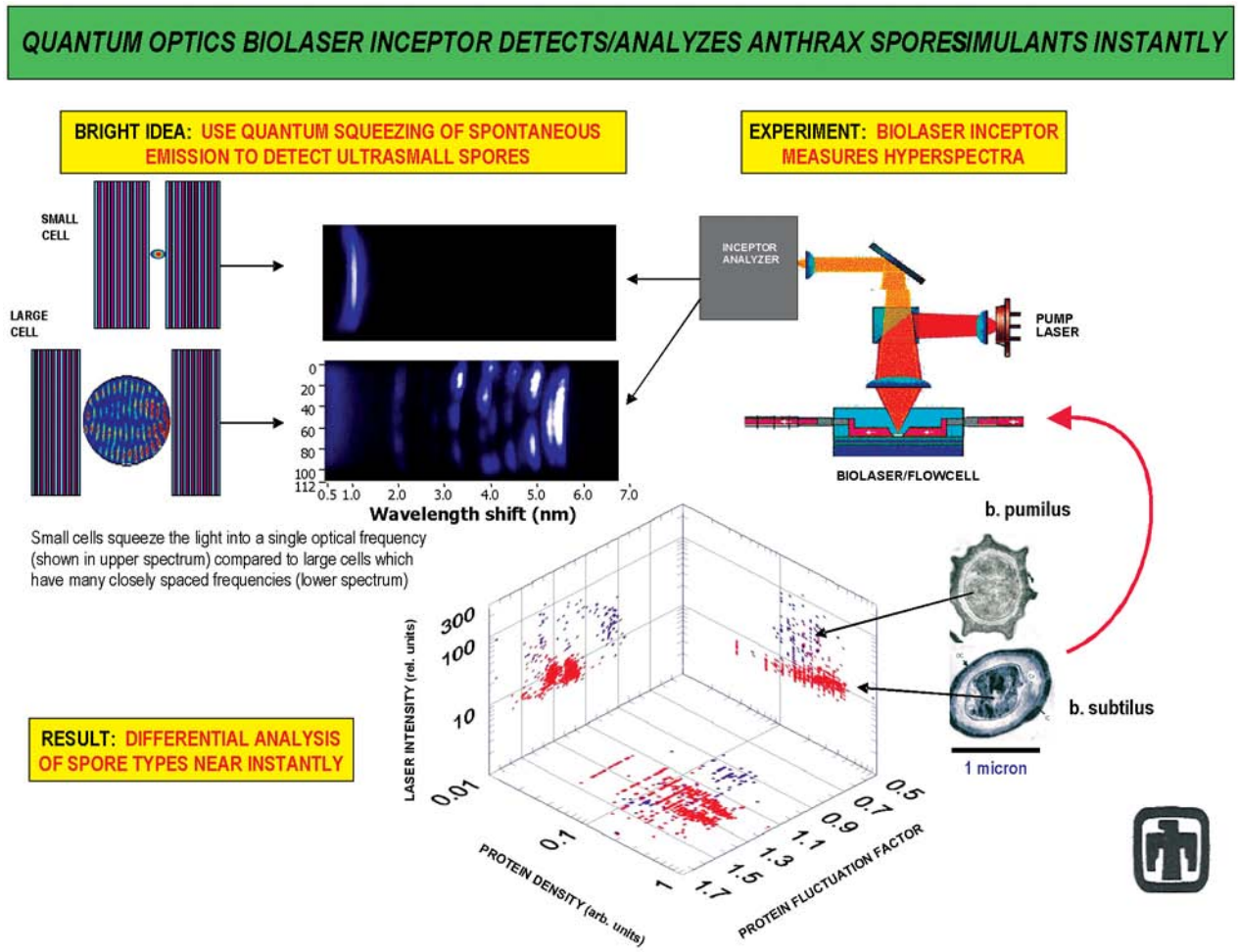

Figure 1. The upper left figure is an illustration of nano-squeezing of light through cells. The upper right figure represents an experiment for measuring spores. The lower figure is a measurement of spores showing different signatures for *b. pumilus* and *b. subtilus*.