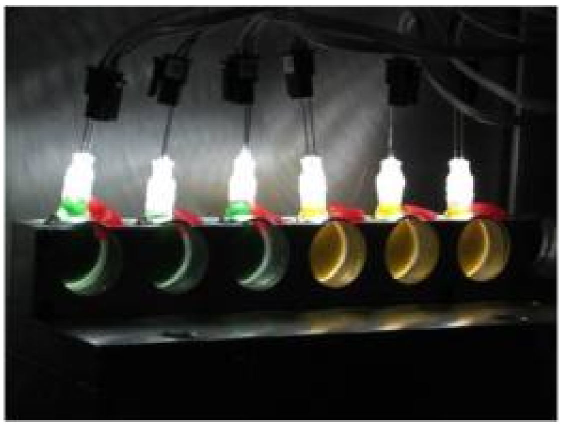
'Low tech' light in neutron beam illuminates photosynthesis in bacteria

September 28 2011, By Agatha Bardoel



Researchers at the Bio-SANS are using this new LED lighting tool to study the light response of the membrane stacks in blue-green algae found in almost every environment.

(PhysOrg.com) -- Researchers at the Bio-SANS instrument at the High Flux Isotope Reactor are getting a leg up in their research from an ingenious "low tech" lighting tool that can be fixed to their samples and then pushed directly into the neutron beam, to illuminate the response of layers of cyanobacteria to changes in light.

"It's really low tech," says Volker Urban, lead instrument scientist on the Bio-SANS, with a grin. "You can buy the parts anywhere." The lighting tool is the work of graduate student Brad O'Dell, a visiting intern from Cambridge University in the United Kingdom. The device combines light emitting diodes with the electronics that drive the illumination.

Parts off the shelf it may be, but the device facilitates research into biologically inspired solar cell devices, important alternative energy-related research being conducted with funding from the Photosynthetic Antenna Research Center one of the Energy Frontier Research Centers in the US.

Photosynthesis is the process by which plants convert sunlight into energy. Bacteria, algae and plants have natural sensors called light-harvesting antenna systems that capture the sun's light and transfer the energy to reaction centers, where the electron transfer for photochemistry occurs. Such antenna complexes are highly specialized in nature, allowing organisms to capture the maximum light energy available in their environment.

Researchers at the Bio-SANS are now using the new LED lighting tool to study the light response of the membrane stacks in cyanobacteria, a blue-green algae found in almost every environment, from oceans to fresh water to bare rock to soil.

At the Bio-SANS, the bacteria are loaded into cuvettes, small sample holders that resemble tiny transparent banjos. An LED is fixed to the top of each cuvette. The array is then pushed into the sample holder and the neutron beam passes through a window, taking "pictures" of the response of the layers of the bacteria to variations in light from the attached LEDs.

"We push the samples into the neutron beam - and then from the neutron scattering we can observe how the structure changes, depending on how much light of which color we shine on the samples," Urban said. "Ultimately, we want to find out how nature has solved the problem of optimizing the efficient use of solar energy through these intricate architectures of antennas. These collect sunlight and funnel the light energy to reaction centers, where it is converted into chemical energy that can be stored for further use," he said. "If those fundamental principles are better understood then they can be used to create new, more efficient solar panels." They have already made some observations. "In a preliminary experiment, we could see with neutrons that the membrane stacking in the cycnobacteria changes in response to light on/light off," Urban said. "With this new light in place, we can now study this response more precisely, and in more detail: How does it depend on the intensity and the color of the light?"

In related recent work, also funded by PARC, Urban and his collaborators performed small-angle neutron scattering studies to obtain structural information about the photosynthetic apparatus of the light-harvesting chlorosome complex, the light-harvesting B808-866 complex, and the bacterium Chloroflexus aurantiacus. "To our knowledge, this was the first SANS report regarding the overall photosynthetic machinery of Cfx. Aurantiacus," Urban said.

Subsequently, the researchers studied in greater detail the light harvesting antenna chlorosome. Chlorosomes, from green photosynthetic bacteria, are the largest and one of the most efficient light-harvesting antenna complexes found in nature. The chlorosome is able to absorb solar energy and convert it into chemical energy under both low and high light conditions. Its unique properties make it an attractive candidate for developing biohybrid solar cell devices.

The paper that resulted was the first to investigate the ionic strength effects of chlorosomes, whose size, shape, and orientation of the light-harvesting complexes are critical to understand for the phenomenon of electron transfer to semiconductor electrodes in solar devices.

"These studies are useful for developing biomimetic and bioanalytical solar cell devices, and for demonstrating that chlorosomes are alternatives to other protein_pigment complexes produced in photosynthetic organisms," Urban said.

Provided by Oak Ridge National Laboratory