BOSTON UNIVERSITY PHOTONICS CENTER
PROBLEM STATEMENT SCRIPT

Professor Ruane: Good morning Sunmin! Julia! We're going to be approaching Provost for funding to develop a DNA fabricator, you know, an optical system to make DNA microarrays. The research group has identified your backgrounds as being the right match for this project. We need to justify our request for funding- what do you think we should we explain to the Provost in our proposal?

Julia Well, first I would explain to him what a DNA microarray is! It's a regular pattern of thousands of DNA strands chemically attached to a substrate material. Although microarrays are small, they contain a huge amount of genetic material and can be used for rapidly completing hundreds or even thousands of DNA tests at the same time.

Our lab is developing several new sensors to quickly read the results of microarray tests. We need the ability to make our own microarrays, because we can only get certain configurations from the commercial suppliers. We could do a lot of new experiments if we could make our own custom arrays.

Sunmin: Besides the research going on in our lab, BU has a large bioinformatics group, and they would love to be able to have custom microarrays available, patterned with whatever DNA sequences they want. We would to able to provide them- if we could make them ourselves.

Professor Ruane: That sounds good! What should I say about the optics and biochemistry we need to make this project work?

Sunmin: I guess I'd have to do more research on the specifics of the photochemistry. As you know, DNA is made up of just four bases- guanine, cytosine, adenine and thymine. To make a micro array, the bases are added one at a time, and the DNA strands are built up base-by-base. Each base is topped by a protecting group called NP-POC. When the protecting group is exposed to the right ultraviolet wavelength, it's cleaved off from the DNA base. That allows the next base to attach there. By exposing bases to UV light, we can build up the DNA sequences we want, layer by layer, across the microarray. We can make different sequences in different locations by choosing where to direct the UV light.

Julia:. So, we need to get ultraviolet light onto certain spots, and the spots will change with each layer. The microarray is a couple of centimeters across so we would probably use a digital micromirror device to direct the light. These are the same devices used in digital TV projectors and they can be controlled by a computer. I'll have to come up with an optical design to take the light from a UV lamp, direct it onto the micromirrors, and then to the substrate where the chemicals are.

Professor Ruane: So, once you have an optical design, it's a matter of choosing the right wavelength for the photochemistry, and making sure you have a high enough irradiance to get the exposure you need. That will determine the exposure time.