Introduction and Background

Nanotechnology offers many potential areas for product improvements. One field, in particular, that is being aggressively explored is the biomedical field. An example of a biomedical application that could greatly improve disease diagnosis is the development of Labs-on-a-Chip (LOC). These small, portable, inexpensive devices can be used to quickly and conveniently run tests on very small amounts of fluids, such as blood, when and where needed. This project will explore the design and use of a LOC to study operational aspects of devices of small scale.

Fluorescein is a chemical that is used to detect an eye disorder known as dry eye syndrome. This disorder reduces the flow of tears to the eyes, creating symptoms such as itching, burning, redness, and blurred vision. It is estimated that as many as 10 million people suffer from this ailment. To diagnose this problem, physicians need to measure the flow rate of tears coming into the eyes. By putting a small amount of fluorescein into the eye and measuring the change in its concentration in tears over time physicians can determine tear flow rate. As new tears enter the eye, the fluorescein concentration is decreased. The tear flow rate can be compared to normal flow rates to identify the “dry eye” problem.

Typically this test is done with expensive instruments in a doctor’s office. Samples of tears are taken from the eye in micro-liter amounts. This project’s objective is to design a cheap, portable Lab-on-a-Chip, LOC, design to measure the concentration of fluorescein. The benefit of this device would be to greatly reduce the cost of equipment required (fluorophotometers) as well as to provide a product that is readily portable. Portability is very helpful in situations where older or disabled patients find it difficult to travel to a doctor’s office.

The LOC project consists of designing two different chip designs. The first chip will be designed in the early part of the semester and the second chip, which will be designed later. The two-step design approach will allow for improvements from the first design and ultimately enhance LOC performance.

Additional Lab Components

In addition to the hands-on lab experiences and documentation described above, the following components are provided to enhance the lab experience and relate current nanotechnology research to the microfabrication analog provided within the confines of the lab.

Nanotechnology Teaching Modules (NTM)

Nanomanufacturing involves the precise manipulation and placement of individual molecules and an understanding of scientific principles applied at the molecular scale. An important part of this lab project is developing hands-on experience with micromanufacturing and knowledge of the challenges you would face in reducing the size scales a further 3 orders of magnitude to the nanoscale domain. To help with the latter, we have commissioned several
faculty members around the university whose primary research is in an aspect of nanotechnology to write short modules on a specific topic. These modules form an integral part of your lab assignments and will comprise a significant part of your lab memos. They are assigned at times that best correspond to the subject matter of specific segments of the design-build project. When a module is assigned you are to read the module and answer the assigned questions from the module as a part of your lab memo. There are also quizzes on Carmen that need to be completed. The modules are available in this lab packet.

**Nanotechnology Lab Tour**

Students will also go on a tour of some of the nanotechnology labs on the OSU campus, and will write a summary of this experience. To prepare for this tour and for the requirements for the summary, see the Lab Tour Summary section of this document.

**Goal of the Lab**

The goal of the lab is to develop, test and document a lab-on-a-chip prototype designs based on the requirements listed in this document.

Each team will create two prototype designs for a portable device to be used for the detection of fluorescence of a chemical solution. Through the course of the initial labs the teams will experiment with a generic prototype of a lab-on-a-chip which will expose the teams to the necessary operational and equipment characteristics to enable them to create new designs. Actual prototype devices will be manufactured from Solidworks drawings of these designs and will be tested and calibrated for use in a final test evaluation.
Overall Project Goals

• **Project Management and Teamwork** – To successfully bring any complex project to completion requires proper planning and the coordinated effort of a group of people. To help your team achieve this goal, you will be introduced to the basics of project management and teamwork. This includes, but is not limited to: time management and task scheduling, team communications and meetings, fair division of labor and team member responsibilities. You will be expected to produce related documents such as a work breakdown structure, a project schedule, and team meeting records, all of which must be regularly updated and kept in the team project notebook. Additional information is included in the Project Management and Project Notebook sections of this document.

• **Design Process** – Rarely, if ever, does a new design work perfectly the first time. Your design project will likely be no exception to this. While it is a lot of fun to dive right in and start prototyping any sort of project, your team will reach a useful design much sooner if you follow a more formalized approach to the design process. In short, it consists of: identifying the project requirements and constraints, gathering background information, brainstorming, identification and management of materials, initial analysis & design, and the build/test/modify/document cycle with two iterations. As part of this process, you will produce the initial design, document any revisions to it as they occur, and produce the 1st and 2nd design documentation that accurately reflects your designs. You should also keep the initial, 1st and 2nd designs, with all revisions for both chip design, in your project notebook. For more details, read the Chip Requirements, Project Management and Project Notebook sections of this document.