INDUSTRIAL SOLUTIONS LABORATORY

Company Information

Company Name	*ASML*	**Date Submitted**	*11/29/2023*
Project Title	*Precision Mechanics – High Precision Piezoelectric Actuator Mount (ASML_MOUNT)*	**Planned Starting Semester**	*Spring 2024*

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills.

Discipline	Number	Discipline	Number
Mechanical	5	Electrical	
Computer		Systems	

Company and Project Overview:

ASML is the leading photolithography tool supplier to the semiconductor industry. We engineer, design, build, market, install and maintain the machines that print the majority of the semiconductor chips used in computers, cellphones and elsewhere.

ASML's headquarters are in The Netherlands, where the main engineering and integration site is located. The company also has two large hardware engineering and production sites in the US: Wilton CT (ASML US), and CA (Cymer). Cymer produces the light sources that enable the lithography process. This includes Deep Ultraviolet Lasers (193nm wavelength - light path in air and water) and the Extreme Ultraviolet Light Source (13nm wavelength – light path in very low pressure hydrogen). ASML US in Wilton produces all variants (including DUV and EUV versions) of several major modules of the TWINSCAN® Lithography machine: The Reticle Stage, the Reticle Handler, and several optical modules, including Wafer Alignment, Wafer Level Sensing (topology mapping), and Actinic Light Uniformity Compensation. All EUV modules are designed to operate in ultra-clean vacuum environment. In addition, Wilton also produces the optical module of the YIELDSTAR® in-line wafer inspection tool.

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This Student Project will be sponsored by the Mechanical Development Group of ASML US Wilton CT, and will target one of the mechanical issues that are intrinsic to our capability to keep up with an aggressive roadmap, where our machines have to perform at ever decreasing error levels to enable printing ever smaller features on chips. The issue is to improve the precision of piezoelectric actuator mounts as described below:

Piezoelectric actuators are used extensively in many small range translation mechanisms. However, they can induce significant errors in the motion of the platform. This is exacerbated by the fact that parasitic motion errors tend to be hysteretic and therefore difficult to compensate. Unfortunately, the mounting requirements also conspire against the designer. For transmission of displacement; a high preload is often necessary, the stiffness of components in the direction of motion should be as high as possible, off-axis stiffness should be as low as possible, parasitic motions of the actuator should not be transmitted to the moving stage, the stage should be capable of supporting large loads, the complete systems should have a high resonant frequency etc. In short, the requirement is to couple the actuator to a stage with minimum lost motion in a single axis only. In this project, a number of mounting strategies will be investigated and optimum design configurations sought. The project may optionally investigate the use of rigidly-coupled PZT elements for nano-scale adjustment of structures.

Project Requirements:

The students, in consultation with advisors at UNCC and ASML, shall:

Acquire a basic understanding of typical precision mechanics applications of piezoelectric actuators, such as micro positioning stages. Also study any other precision mechanics devices or structures of possible interest for this project. The students will also learn how to implement and use position sensors to accurately measure relative displacements in test samples.

The main goal will be to capitalize on the theoretical understanding to be able to create a design that has high performance, is practical, reliable, compact and inexpensive. The students will spend the first semester designing and the second semester building and testing a proof of concept prototype of the piezoelectric actuator mount or the PZT adjusted structure.

The development steps will comprise:

- Generate conceptual designs
- Down-select to best design
- Design the prototype
- Order all purchased components.
- Build the prototype.
- Demonstrate and test the prototype.
- Write a report, including:
    - test results,

- lessons learned,
- recommended improvements,
- conclusions.

Expected Deliverables/Results:

- Conceptual design(s) according to the above.
- Concept Design Review (CDR) of the above to be attended/approved by the sponsor.
- Final proof of concept design(s), including specifications, calculations, models, BoM, etc.
- Prototype Design Review (PDR) of the proof(s) of concept to be attended/approved by the sponsor.
- Working prototype
- Final report including test results and outline of way forward.
- Periodic progress reviews with the sponsor (suggested weekly ~ 1 hour),
- PDR and CDR meetings
- All sponsor meetings virtually on Zoom, or equivalent platform.

Disposition of Deliverables at the End of the Project:

Prototype hardware, software, results, etc. shall be presented to the public in full detail at the EXPO.
Prototype may remain at UNCC after completion of the project, for re-use in follow-on ASML-sponsored projects.

List here any specific skills, requirements, specific courses, knowledge needed or suggested:
Skill/knowledge/interest:

- Strong interest in precision mechanics.
- *Finite Element Analysis skills (structural, thermal).*
- *Manufacturing (machining) skills.*
- *Knowledge of test set-up, Labview and general lab skills.*
- *Students who have some knowledge of electronics would be a plus.*

At the outset of the project, ASML requires no specific knowledge beyond acceptable academics in Engineering. However, the individual(s) must be willing to dedicate substantial effort towards "on the job" learning in the areas outlined above.

Each student may be required to sign an ASML Non-Disclosure Agreement.