Specifications for Photolithographic Mask Aligner System

Section 1.0 General Requirements

1.1 Scope. This specification describes the minimum technical requirements and the minimum acceptable performance standards for a photolithographic mask aligner to be installed, by the contractor, at the Naval Research Laboratory (NRL), Washington, DC. This system will be used by NRL personnel to transfer patterns from a mask to a wafer or substrate using contact lithography. The mask aligner will be placed in a multiple user facility and must provide ease of operation and safety to those in the facility.

1.2 Installation Site. The contractor shall install the mask aligner in Bldg. 250, Naval Research Laboratory, Washington DC 20375, at a specific location to be designated by the Authorized Government Representative (AGR). The NRL will be responsible for providing the necessary facilities at that location for the proper installation of the tool. The contractor shall install the system in a manner consistent with typical clean-room operating procedures.

1.3 Description and Primary System Components. NRL researchers will use the photolithographic mask aligner to transfer patterns from a glass or quartz mask to a wafer or substrate using contact lithography. This process utilizes ultraviolet (UV) light to define a pattern in photo resist that, with subsequent processing, allows the construction of 2-dimensional devices having edges defined with micrometer resolution. At times they will construct more complicated devices using multiple 2-dimensional structure levels, and the relative alignment between levels will be 1.0 micron (μm) or less. Research personnel may construct other devices from 2-dimensional structure levels on both top and backsides of a wafer or substrate. The Contractor must deliver and install a system the NRL researchers can use to achieve these ends. Further, the relative alignment between top and back levels, using an infrared (IR) light source for viewing, must be 2.0 microns or less.

The system must be composed of the following three major components:

- A mechanical stage supporting the sample and mask and allowing alignment to be carried out between them.
- An optical source and exposure system capable of delivering UV radiation to the sample for a programmable period of time
- A microscope system to be used during alignment of the sample to the mask.

2.0 Mechanical Subsystem Requirements

2.1 Sample size. The mask aligner must be capable of handling a variety of sample sizes, including but not limited to 0.5 – 8 inches (") diameter wafers up to 1.5 millimeter (mm) thick. It must take no more than 10 minutes for the operator to change mask and/or sample holders.

2.2 Mask holder. The mask aligner must be capable of handling from 4"x 4" to 9" x 9" square masks. The mask and holder changing must take the operator no more than 5 minutes. The instrument must provide capability of loading masks from either side of the appropriate mask holder. A 4" top load vacuum mask holder must be provided.

2.3 Mask alignment. The system must allow relative mask-sample motion in x, y, and theta θ (rotation) directions. X-Y range must be at least ± 0.15" and theta must be at least ± 10°. Alignment accuracy must be less than 0.5 microns

2.4 Mask - Sample separation. The mask aligner must allow a continuously variable separation between mask and sample in the z (height) direction with a minimum range of at least 50 microns.

2.50 Contact Modes.

2.51 Contact Modes - Description. The contact mode refers to the nature of the wafer/sample contact during exposure. Soft contact mode refers to mechanical force applied to the wafer/substrate interface. Vacuum contact is achieved by applying a vacuum to the interface region between the mask and substrate.

2.52 Contact requirements- The instrument must provide both mechanical and vacuum contact. Vacuum contact must be achieved by applying a vacuum to the interface region between the mask and substrate. A gauge must be provided for readout of the vacuum applied.

2.6 Sample holder. The sample holder must have the capability for vacuum hold of the wafers and for vacuum contact during exposure. A separate switch that actuates the vacuum hold during exposure must be provided for the sample holders. The aligner must be provided with standard topside 1", 3", and 4" chucks that are capable of planarizing the contacting surfaces between the mask and sample.

Section 3.0 Optical Subsystem

3.1 UV source requirement. The mask aligner must utilize a mercury lamp, rated at a minimum of 350 W and using a power supply capable of operation at 110 VAC, 60 Hz power. A minimum of two spare lamps must be provided. Power supply and lamp house must be provided in separate units. The lamp house must prevent accidentally exposing the laboratory environment to UV radiation. The power supply must be capable of recording cumulative lamp operating time and controlling lamp intensity and/or power.

3.2 UV spectral range. The mask aligner must be configured to operate in the UV spectrum. Namely, it must provide spectral power in the range of 365-400 nanometers (nm) with an output intensity of at least 20 milliwatts (mW)/cm^2 @ 365nm and at least 40 mW/cm^2 @ 400nm.

3.3 Beam. The beam must be at least 6" in diameter with an intensity variation less than +/- 5% over a 6" diameter area. The measurement must be taken in the plane of the substrate.

3.4 Exposure timer. The exposure cycle must be automatic, activated by a simple switch or button, and time-programmable between a minimum range of 0.1 to 999.9 seconds.

3.5 Intensity control. The UV beam intensity variation must be less than +/- 2% during exposure.

3.6 Intensity meters. An intensity meter must be included that monitors and displays UV source intensity during exposure. The meter must be sensitive to radiation between 365 and 400 nm. A separate intensity meter and probe must be provided to allow the operator to measure UV intensity in the 365-400nm range at various points around the substrate table.

3.7 Print resolution. The line resolution must be 0.6 um or less, using vacuum contact, over a central 6" diameter area.

Section 4.0 Microscope System

4.1 General description. The aligner must be equipped with a Zeiss Split Field Microscope with 5x, 10x, & 20x objectives, 10x and 20x eyepieces. A microscope of comparable range of magnification and positional range (see below) is acceptable. If a new microscope is not available a refurbished one with the same warranty as a new unit is acceptable. The microscope must have an objective separation range of at least 20-120 mm.

4.2 Positional Range. The microscope must be provided with independent scanning movement in the x and y directions. The required minimum travel in x and y directions is ±40 mm, having the origin at the center point of the mask.

4.3 Aligner must be equipped with a visible/infrared charge coupled device (CCD) camera with at least a 13" black & white or color monitor with all required cables, connectors, and mounting hardware. Infrared sensitivity must be from 0.8 to 1.2 microns.

Section 5.0 Miscellaneous

5.1 Manuals, drawings and documentation. One complete set of operating and technical manuals, including full instructions for all system hardware, must be provided. Schematics, diagrams, and drawings of the mask aligner must also be provided.

5.2 Special tools. Special tools required during normal operation or maintenance of the mask aligner, must be provided.

5.3 Vibration isolation table. A high performance vibration isolation mask aligner support table must be provided meeting the following requirements:

5.3.1. Dimensions of at least 36" W X 48" L X 35" H

5.3.2. Stainless steel laminate top with brush finish

5.3.3. Gimbal piston isolators for vibration isolation

5.3.4. Load capacity of at least 350 lbs.

5.3.5. Retractable casters (4)

5.3.6. Power supply shelf

5.4 Spare Parts. System is to be provided with commonly used spare parts. (such as replacement bulbs, gaskets, o-rings, fuses, misc. small screws etc.)

5.5 Installation and Training The Contractor must install the system in the required facilities available at the designated location and provide the necessary training for complete operation and routine maintenance of the tool to a minimum of five NRL researchers.

5.6 Commercial item. A developmental model is not acceptable, and only a system that has been commercially sold and available will be considered.

Section 6.0 Options

6. 1 **Option 1 Substrate chucks** must meet the following requirements:

6.1.1. Standard top side 2" planarizing wafer or substrate chuck.

6.1.2. 2.0", 3.0", 4.0", 6.0" & 8.0" planarizing IR backside/top side spot Illuminated chucks.

6.1.3. Fiber optic illuminators and bifurcated quartz fiber optic pipes for above IR chucks.

6.2 **Option 2 Vacuum Mask Holders** must have the following requirements:

6.2.1. 3", 5", 6", 7", & 9" Top load vacuum mask holders

6.2.2. Bottom load mask holding for above holders

6.3 **Option 3 Exposure System** must have the following requirements:

6.3.1. 500 Watt UV exposure system and intensity controlling power supply with 365nm output beam intensity of at least 30 mW/cm^2, and 400nm output beam intensity of at least 60 mW/cm^2

6.3.2. 500 Watt UV/Deep UV exposure system and intensity controlling power with, 365nm output beam intensity of at least 30 mW/cm^2, 400nm output beam intensity of at least 35 mW/cm^2, 220nm output beam intensity of at least 7 mW/cm^2, and 254nm output beam intensity of at least 10 mW/cm^2

6.3.3. 280/310nm DUV mirror set

6.3.4. Spare 350 Watt UV lamp

6.3.5. 220/254 nm light probe

6.3.6. 280/310 nm light probe