Specifications

The Naval Research Laboratory requires a versatile laser cutting system to provide drilling, grooving, scribing, thinning, and marking functions in support of several R&D projects. The unit will be installed at the Naval Research Laboratory, Washington, DC (NRL-DC) in the clean room within the Nano science building.

The following system specifications are required:

1. **Laser:** The laser should be of a wavelength to provide the most versatile cutting tool for a variety of materials including metals (aluminum, stainless steel, copper), semiconductors (Group IV including diamond, III-IV and II-VI semiconductors), hard materials (graphite, metal-nitrides, boron nitride), ferrites, ceramics, glass, quartz, alumina, and refractive metal oxides. A pulsed beam, solid state Nd:YAG laser is preferred. The output power should be at least 100 Watts. The laser beam diameter should be variable within a range of 25 – 100 micrometers. A long working distance up to 100 mm is preferred. Water-jet guided laser systems are preferred.

2. **X-Y Table:** The cutting table should be of a size to mount 3 inch, 4 inch and 6 inch diameter semiconductor wafers and variously sized work-pieces ranging from 3x3x1 mm up to 300x300x5 mm. It must have a stable base with computer-controlled X and Y motion. (X and Y directions are normal to the direction of the laser and orthogonal to each other.) The working area must be at least 300 mm x 300 mm. The stage should be capable of supporting a mass of 1 kg or greater. The motion accuracy must be better than ±3 microns or less and the repeatability ±1 micron or less. The maximum axis speed must be greater than 600 mm per second and have a maximum acceleration of at least 20 mm per second squared.

3. **Cooling:** The work piece must be dynamically cooled during machining to minimize thermal damage, i.e., no evidence of a heat-affected zone, oxidation or discoloration of the work piece. The system should utilize filtered, de-ionized water-spray cooling to dissipate heat and provide active cleaning of the sample. Water pressure should be adjustable within the range of 20 – 500 bar and support flow of up to 50 ml/min, minimum. (Filtered and de-ionized water – 5.5 bar pressure – is available at the NRL-DC installation site.)

4. **Alignment System:** The alignment of the work piece must be automated using an optical imaging system to an accuracy of less than 10 micrometers in x and y directions and 0.1 degrees in theta. (Theta is considered rotation in the x-y plane.) Alignment systems that utilize computer-based video capture and CAD overlay to fiducial marks on the sample are preferred.

5. **System-Facility Compatibility:** The cutting tool will be housed in a Class 100 cleanroom and therefore must be compatible with operating in this environment. The work piece and surrounding environment must be kept clean – free of contamination and burrs during operation. There must be no gas emission from the system.

6. **Computer-based System Operation:** The system must be user friendly and easy to use by many different users and requires computer interface and control. Windows based systems are preferred. The machine must be able to connect to a LAN network for data transmission. A connection to permit remote diagnostic service is also required. The machine must also have the capability to accept CAD data in GDS-II or DXF formats or provide layout software and licenses for three computers (minimum) to allow off-line preparation of cutting recipes that may be transferred via LAN to the cutting system.

7. **Laser marking capability:** The system must be capable of writing alphanumeric text to the surface of a sample through the use of a computer interface that allows for variable size and placement of the text on the surface. Water cooling may or may not be required for marking operations.

8. **Low Cost of Ownership:** Systems that minimize or eliminate the need for expensive tools and consumables are preferred. Evidence supporting negligible tool wear is a plus.

9. **Installation and Training:** A factory-trained technician must be present at NRL-DC to assist in the initial start up of the laser cutting system and to provide initial system calibration, testing and personnel training for at least three (3) days and 12 people.

10. **Warranty –** A Standard commercial warranty of at least one year.

11. **Options:**
    a. Z-axis control
    b. Rotary motion control.
    c. Spare parts and critical components kit including replacement nozzles, high-wear and short-lifetime components.
    d. Extended warranty to include service engineer travel, replacement parts, and repair within 5 days of being reported for up to three years.

12. **Acceptance Tests**. The following tests are to be demonstrated after installation at NRL-DC and prior to acceptance of the tool:
    a. Silicon wafer saw cut. The system must demonstrate a silicon wafer saw cut from edge to edge through the center of a 100 mm DIA silicon wafer of standard thickness. The kerf must be 40 micrometers or less.
    b. Stage accuracy. Dots having diameter 30 um or less will be made on a silicon wafer at 1 cm intervals to form 10 x 10 cm array. The dots must have center features that align to the array with less than 3 um RMS as measured by a laser interferometer motion system and scanning electron microscope.
    c. Materials cutting tests. The system must demonstrate the ability to cut silicon, diamond, GaAs, alumina, glass (microscope slides), aluminum, stainless steel, copper, and boron nitride.