DEFENCE R&D DÉFENSE

Defence R&D Canada – Valcartier

Micro Systems Laboratory Facility

The DRDC Valcartier Microsystems Laboratory consists of two clean, Class-US 1000 rooms for photolithography and sputtering deposition.

Sputtering Deposition

Two rf/dc magnetron sputtering vacuum systems (both with turbo pumps and using POLYCOLD refrigeration systems for moisturepumping/ trapping) are set up to deposit semiconductors such as Si, Ge; dielectric materials such as silicon dioxide and silicon nitride; superconductors such as YBaCuO and BaSrCaCuO; and metals such as Au, Cr, Al, Cu.

Two furnaces (Lindberg 54233, T_{max} = 1500ºC) are available for film transformation from amorphous to polycrystalline state, to enhance adhesion between films, reduce defects in a film and to introduce impurity into a substrate via diffusion. Films annealed in the laboratory include BaSrCaCuO superconductor film, Si3N4, etc.

A Tegal 903e plasma etcher for film etching, bulk and surface micro-machining is set up for silicon, silicon dioxide and silicon nitride etchings.

Electrical connections can be achieved using a Kulicke & Soffa wire bonder.

A seam sealing packaging system (Model 2300) is available to encapsulate the developed device into a standard package such as TO-5 after fabrication and subsequent wire bonding.

Photolithography

A Karl Suss mask aligner is available to transfer a pattern from a photomask to a sample by exposing the photoresist-coated sample to ultra violet light. The exposed photoresist is dissolved in developer, while the unexposed photoresist remains to protect the region underneath in subsequent etching and other process. It is equipped with a Mercury arc lamp with peak intensity of 350-500 nm for sub-micrometer dimension.

Characterization

A Jeol 5800 scanning electron microscope (SEM) is equipped with an Elphy e-beam writing sytem from Raith for sub-micron lithography. Instead of using an ultra violet light source (350 – 500 nm) for exposure, as in conventional photolithography, a focused electron beam is used to expose a layer of electron-sensitive polymethy methacrylate (PMMA) applied on a substrate. By controlling beam scanning on the PMMA surface followed by subsequent PMMA developing, one can create a pattern on the PMMA. Because an electron is much smaller than the wavelengths of ultra violet light, line width created by e-beam writing can be extremely small, in the order of 50 nm. As a result, devices with submicrometer features can be created.

The SEM is also equipped with a MAXray Wavelength Dispersive Spectroscopy (WDS) / Vantage Energy Dispersive Spectroscopy (EDS) system from Noran for material and film composition analysis. The EDS is for the characterization of materials with atomic number greater than boron with a sensitivity of 0.1 % concentration and higher. The WDS is for the characterization of materials including elements lighter than boron with sensitivity below 0.1 %. WDS sensitivity has an order of magnitude greater than EDS. EDS is used to gain an overall element composition, while WDS is used for high precision characterization.

A Sopra GSEP 5 ellipsometer is used to determine the refractive index of thin films such as dielectric materials and semiconductors. At various incident angles and wavelengths, measurements are made for different states of polarization, caused by the phase changes of reflected light. The refractive index, also known as the complex refractive index, can be calculated from the measured ellipsometric parameters, amplitude ratio and phase shift, respectively.

A spectrometer for spectral characterization is used to measure the transmission and reflection of a thin film such as VO_2 and Si_3N_4 and the spectral response of an optical detector.

Characterization obtained by the EDS System

For more information

Project Leader
Phone: (418) 844-4000 ext.: 4218 Fax: (418) 844-4511

Defence R&D Canada – Valcartier
2459 Pie-XI Blvd North, Val-Bélair, Quebec G3J 1X5
Phone: (418) 844-4000 Fax: (418) 844-4635
collabo-valcartier@drdc-rddc.gc.ca

www.valcartier.drdc-rddc.gc.ca

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