

SUBMICRON-SCALE PATTERNING OF GaSb FOR PHOTONIC DEVICES

M. Guziewicz, T.T. Piotrowski, K. Gołaszewska, A. Piotrowska, E. Kamińska, E. Papis,
Institute of Electron Technology, Warsaw, Al. Lotników 46

J. Wróbel
Institute of Physics PAS, 02-668 Warsaw, Al. Lotników 46

GaSb-based semiconducting compounds hold great promise in the area of photonic devices such as LEDs, lasers and detectors operating in the mid-infrared range of wavelengths. The processing of these materials, however, is much less advanced as compared to GaAs and InP-related ones. Recently, circular-grating-surface-emitting GaAs/AlGaAs and InP/InGaAsP lasers producing circularly symmetric, much larger beam than conventional semiconductor lasers have been demonstrated. The aim of this work was to develop the fabrication processes of sub-half-micron circular symmetric grating in GaSb by e-beam lithography and Reactive Ion Etching (RIE). The gratings were patterned by e-beam lithography in JEOL 6400 scanning electron microscope. The pattern of 100 μm diameter circular grating consisted of 200 rings of 0.4 μm line width and of 1 μm period. 0.35 μm wide parallel strips with a period of 0.6 μm were also defined. Either AZ PF514 e-beam sensitive resist or SiO_2/Cr bilayer were used as masking materials. Chlorine-based chemistries such as $\text{CCl}_2\text{F}_2/\text{H}_2$, $\text{CCl}_2\text{F}_2/\text{N}_2$, CCl_4/H_2 , CCl_4/N_2 and BCl_3 were used to etch GaSb. Etchings were performed in a RIE reactor of a diode configuration with a 13.56 MHz power supply and an additional Microwave Downstream (MVDS) sustained by 2.5 GHz frequency. The effects of RIE parameters such as gas composition and gas pressure, as well as the RF power on the etching characteristics of GaSb were examined. We have found that very low, well controlled etch rate of 5nm/min. is possible with $\text{CCl}_2\text{F}_2/\text{H}_2$ plasma. Etch rate is found to increase from 110nm/min. up to 1600nm/min. in BCl_3 plasma with increasing the pressure and rf power, and can be furthermore increased (up to 2 times) by applying MVDS. The smooth and highly anisotropic etching (vertical etch sidewalls) in BCl_3 plasma makes the elaborated process promising for nanostructuring of GaSb-based materials.