Large Scale Oxidation of AlAs Layers for Broadband Saturable Bragg Reflectors

Personnel

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The conversion of AlGaAs alloys to Al_xO_y has received much attention for a wide variety of applications. Rarely, however, do such applications require large-scale lateral oxidation (i.e. 100s of microns). Oxidation of AlAs to Al_xO_y for use as a broadband Saturable Bragg reflector (SBR) requires an Al_xO_y/GaAs mirror with lateral dimensions greater than 300 μm. For the SBR structure described below, the simulated bandwidth extends from 1200 nm to 1800 nm with greater than 99.5% reflectivity.

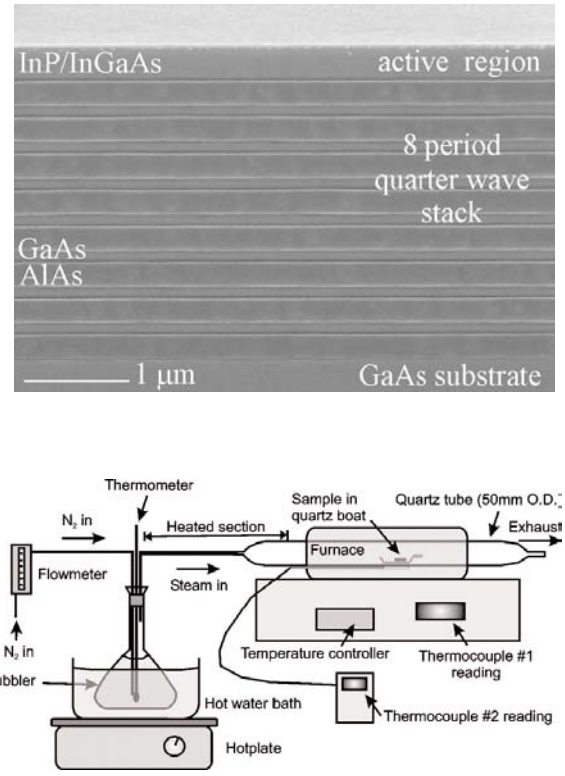

Fig. 26:. a) Cross-sectional scanning electron micrograph of the SBR material system. b) The oxidation apparatus.

The layers within the SBR are grown using gas-source molecular beam epitaxy and are shown in Figure 26(a). The SBR structure contains an 8 period GaAs/AlAs quarter-wave stack grown on a GaAs substrate. The Al_xO_y layer is initially grown as AlAs that is later oxidized. The AlAs layer thickness corresponds to a quarter wavelength in Al_xO_y(n=1.66) plus a 10% shrinkage upon oxidation. The active region consists of an InP/InGaAs quantum well emitting near λ=1550 nm. The InP/InGaAs active region is not lattice-matched to the GaAs substrate and hence a defective interface exists between the active region and the Bragg reflector.

The AlAs is converted to Al_xO_y using a thermal oxidation process [apparatus shown in Figure 26(b)]. The structure was oxidized using a constant flow of N_2 bubbled through deionized water maintained at a constant temperature of 90ºC. The oxidation was performed at several different furnace temperatures. From 435ºC to 415ºC delamination of the active region occurs due to high interfacial stress upon oxidation. Sufficient lateral oxidation depths of over 300 μm are achieved, however, when the temperature is reduced to 400ºC (Figure 27). As an example of an application of the broadband SBR, the structure was utilized to initiate lasing in a Cr^{4+}:YAG laser. High-reflectivity, wide stop-band, and low loss are required for the Cr^{4+}:YAG laser cavity. With the oxidized SBR as an end mirror, self-starting with pulses as short as 35 fs have been achieved with Kerr lens mode-locking.

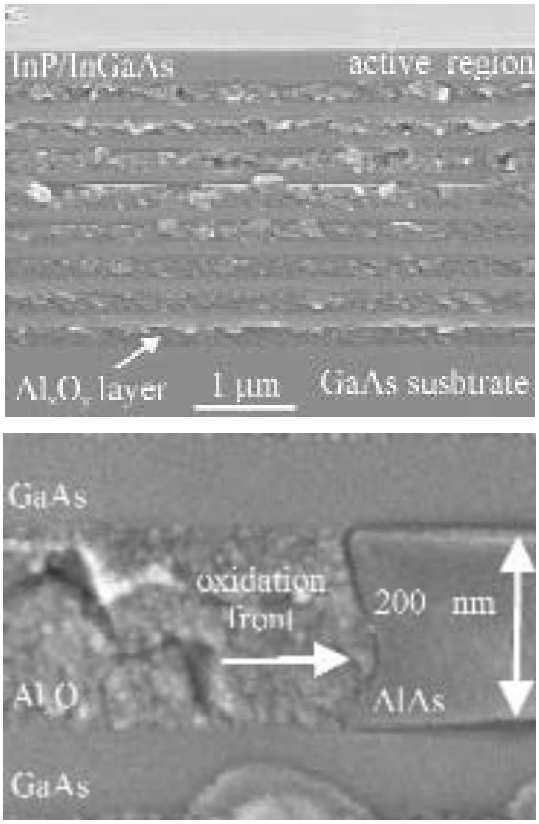

Fig. 27:. a) SEM cross-section of SBR structure oxidized at 400°C. b) A magnified view of the oxidation front in one SBR period.