Growth and Characterization of $Pb_{1-x-y}Cd_xSr_yS$ Films Superlattices and their Application to 2–4 μm Lasers

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The objectives of this research is to study the growth and characteristics of $Pb_{1-x-y}Cd_xSr_yS$ semiconductorsrs and apply them to laser fabrications. Various kinds of films were prepared on BaF_2(111) and KCl(100) substrates by hot wall epitaxy method and their characteristics were studied. For PbCdS films, it was observed that CdS incorporation on (111) surface is larger than that of (100) surface, while for PbSrS films, SrS incorporated equally on either surface. Dependence of CdS and SrS concentrations on the substrate temperature were also studied. For PbCdS films., CdS percentage decreased at higher substrate temperature. Doping was performed with Tl and Bi. PbS, PbSrS and PbCdSrS showed high carrier concentrations and good mobilities, while the carrier concentration and mobility of PbCdS were relatively low. PbCdSrS film lattice-matched to PbS was also prepared. $Pb_{1-x}Cd_xS$/ PbS and $Pb_{1-y}Sr_yS$/PbS SLs were also prepared and their structures were studied by X-ray diffraction measurements. It was observed that considerable amount of Cd is diffused into the PbS layers during the growth, while the amount of Sr diffusion was small. By annealing the PbCdS/PbS SL, CdS diffusion constant was calculated to be $7x10^{-17}cm^2/sec$.

Various kinds of PbSrS/PbS DH lasers were prepared and the effect of cladding layer band gap and active layer thickness on laser operation were studied. $Pb_{1-x}Sr_xS/Pb_{1-y}Sr_yS$ DH lasers were also prepared for the first time and their operating characteristics were measured. The shortest operational wavelength measured for the lasers was 2.07 μm at 140 K. This wavelength is about 0.7 μm shorter than the shortest wavelength ever reported for any IV-VI compound semiconductor lasers.