MOCVD-Deposited Dielectric Films for Integrated Optical and Microelectronic Circuits

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Dielectric films of high quality in break down field and transparency in the visual and near infrared range are presently based mainly on the SiO_2-SiON-Si_3N_4- material system, deposited by thermal oxidation and from inorganic or organic silicon precursors like Silane or HMDS, respectively. In optical applications the pronounced absorption of theses layers at 1.4µm which is close to the optical transmission bands at 1.3 µm and 1.55µm restricts their application, if very low optical loss layers is necessary. Furthermore material absorption in the near UV and MIR ranges, which are of considerable interest for sensors and metrology, does not allow to extend the applications into these regions. Finally also high refractive index materials corresponding to high dielectric constants which allow for sharp waveguide bends and small resonators necessary to generate extremely small optical networks and high capacitance per area e.g. for RAMs are of increased interest.

In this paper MOCVD deposition processes for amorphous and nanocrystalline aluminium oxide and titanium dioxide films and their optical properties in the VIS-NIR spectrum are presented. Losses at 1.55 µm are below 0.1 dB/cm for Al_2O_3 and 0.2 dB/cm for TiO_2. Refractive indices are 1.68 and 2.6 at 633 nm after annealing. Annealing procedures, which allow to generate near crystalline material properties while keeping close to the amorphous or nanocrystalline morphology are presented. By incorporating Ti , Cr, and Er into Al_2O_3 – waveguides introduces highly efficient fluorescence which allows to generate both integrated optical amplifiers as well as optically pumped broad- and narrow band integrated optical lasers. Examples of laser and amplifier structures as well as fluorescent spectra are given and a broad band ring laser is demonstrated