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Porous Silicon Multi Layers based Tunable Optical Filters.

ABSTRACT - Masterthesis

The goal of this thesis is to design and fabricate a porous silicon multilayers(PSMLs) based tunable optical filter which has a very sharp stopband peak with suppressed side ripples and higher order harmonics, tuned with different tunability principles resulting in wideband and narrow band tuning. Porous silicon is an intriguing material with great prospects in optical applications when compared to crystalline silicon. The multilayers formed in porous silicon are key elements of sensor approach and MOEMS optical elements such as Distributed Bragg Reflector, Fabry perot interferometer and Rugate filters. The influence of fabrication conditions (such as doping concentrations, porosity, thickness and number of layers) on the spectral properties of the multilayers is simulated using Essential Macleod Simulation Software. Porous silicon is fabricated by electrochemical anodization of silicon wafer, and by alternating the current density; multilayers structures are fabricated in the single wafer.

The multilayers are characterized and optimized for tunability application, DBRs and Rugate filters are fabricated. The first tunability principle to attain narrowband tuning is a very novel and fresh approach to attain tunability. In this approach the PSMLs optical filter is tilted with respect to normal incident light source, which causes a shift in the stopband peak to a lower wavelength in reflection spectrum and this approach is referred to as "Tilt Effect". In the second principle to attain wideband tunability some particular chemical analytes are introduced in the PSMLs, which change the overall optical behavior of the optical filter, thereby shifting the stopband peak to another wavelength in the spectrum and this approach is referred to as "Pore-Filling". When both of these techniques are simultaneously implemented then it is referred to as Dual Tunability, wherein we are capable of wide-band and narrow-band tuning of the center wavelength. The tunable optical filter formed from PSMLs is very compact, miniaturized, low cost, and easy to fabricate and have a very fast response time. They find applications in optical communications, as well as in sensing applications (because of high specific surface area) and forms the building blocks of miniaturized refractometer, Monochromator and Spectrometer.