Maximum Length Sequence (MLS) Multilayer Reflector using Rigorous Coupled Wave Analysis and FEM

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Broadband reflectors created by multilayer dielectric stacks have attracted the interest of researchers in the fields of optics, wireless communications, and biomedical devices due to ease of design and fabrication. Dielectric reflectors provide good reflectivity, low absorption loss, and a high degree of robustness in the THz through optical frequency regimes compared to metallic reflectors. However, the metallic reflector can reflect radiation from any direction. The first dielectric omnidirectional reflector was experimentally fabricated to reflect the light in the infrared frequency range (Y. Fink et all, Science 282 1998). The dielectric multilayer reflector is a structure built from a specified combination of high and low refractive index layers on a substrate. We investigate via simulation the design of an alternating multilayer of high(Tio_2) and low(Sio_2) refractive index materials with thicknesses determined by an MLS sequence. Maximum length sequences (MLS) are two level binary sequences that are pseudo-random. An MLS has a uniformly flat frequency response except for a DC offset which indicates that these sequences contain all possible periodicities (M.Vishanathan et all ISBN-10: 1301525081, 2013). We characterize the reflection characteristics of such structures in visible frequency range. Further, we compare the reflection characteristics of this MLS with a periodic alternating high and low refractive index multilayer. The MLS structure provide broader band gap compared to other structure due to uniform flat frequency distribution in entire range.The reflection characteristics for broad angle of incident and wavelength for these designs are investigated using rigorous coupled wave analysis(RCWA), transfer matrix, and COMSOL Multi physics finite element simulation. The rigorous coupled wave analysis is a commonly used method to solve Maxwell equations in a semi analytical way for periodic diffraction grating structure.