Structural, Optical and Wettability Properties of Thermally Evaporated CaF_2, MgF_2 and CaF_2/MgF_2 Films

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Abstract

In this work, thin films of CaF_2, MgF_2 and their multilayered stacks have been deposited on microscopy glass substrates by thermal evaporation and their structural, optical and wettability properties have been studied. Four different sets of samples i.e. glass/CaF_2, glass/MgF_2, glass/CaF_2/MgF_2 and glass/CaF_2/MgF_2/CaF_2/MgF_2 were prepared. X-ray diffraction studies revealed that crystalline CaF_2 film grows in glass/CaF_2 and in the 2-layer stacked glass/CaF_2/MgF_2 samples whereas, it grows in the amorphous phase in 4-layered stacked glass/CaF_2/MgF_2/CaF_2/MgF_2 sample. On the other hand, MgF_2 layer in all the samples grows in the amorphous phase. Field emission scanning electron microscopy (FESEM) was used to study the surface morphology and thicknesses of the samples. The surface FESEM image of CaF_2 film shows very small flake-like morphology whereas the MgF_2 film has a smooth morphology due to its amorphous nature. The cross-sectional FESEM images found that the thickness of the pure CaF_2 film (102 nm) is lesser than that of pure MgF_2 film (127 nm). The optical transmittance and reflectance properties were studied by UV-Vis spectroscopy which confirmed that all the films possess good anti-reflecting properties. The average specular reflectance values in the wavelength range: 350-1100 nm are 10.8%, 7.9%, 8.6%, 6.4% and 8.4% for bare glass slide, MgF_2, CaF_2, 2-layer and 4-layer stacked films respectively which confirms that the reflectance decreases with the top coating of the fluoride films. The water contact angle studies were carried out to study the wettability properties of the samples and it is found that the pure $CaF_2$and MgF_2 films are hydrophobic with an average water contact angle 131 ± 1^o and 98 ± 1^o, respectively. The wettability properties of the 2-layer and 4-layer stacked structures were found to be completely different compared to single layer thin films and showed hydrophilic nature with water contact angles of 20 ± 1^o and 47 ± 1^o respectively with reflectance values that were comparable to those of MgF_2 and CaF_2 films. It is concluded that CaF_2 films have a very good potential to be used as hydrophobic anti-reflecting coatings and stacking with other well known optical material such as MgF_2, can tailor its wettability and anti-reflecting properties.

Water Contact Angle Images