ASIA-PACIFIC SOLAR RESEARCH CONFERENCE

Chemical processed AgBiS2 deposition as an absorber layer for high performance solar cell application.

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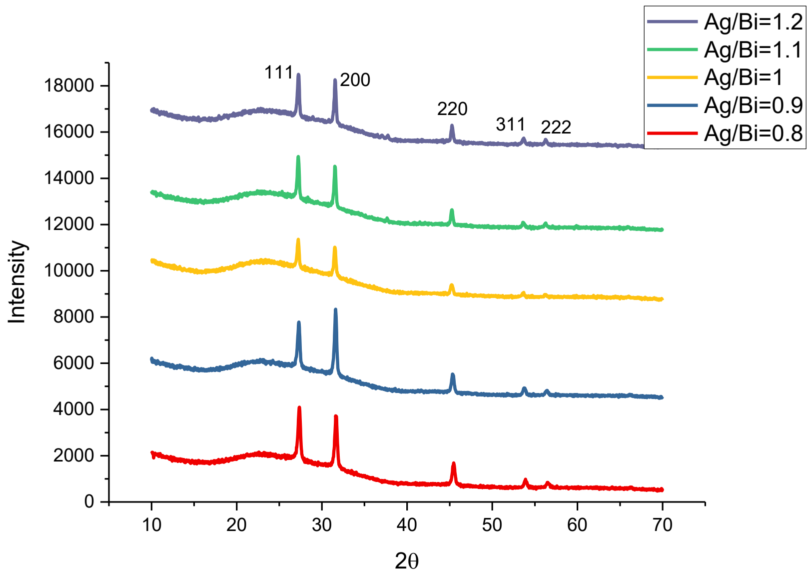
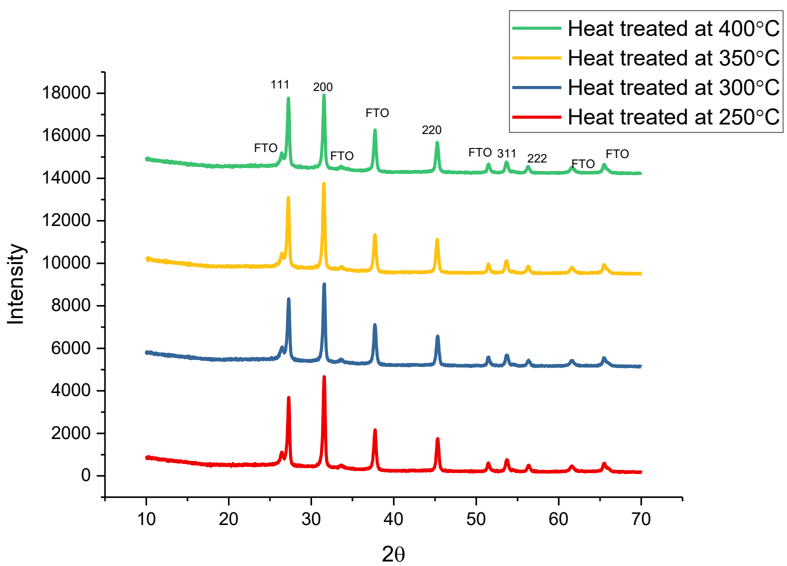
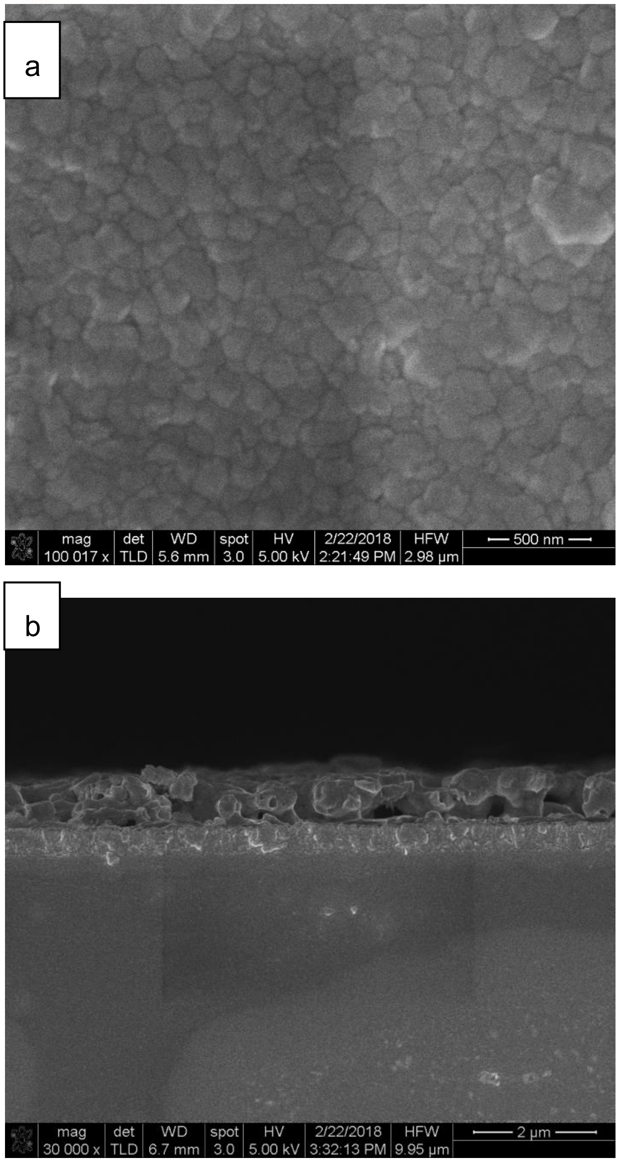
Many of the compounds as absorber layers for high performance thin film solar cell application, being explored contain toxic materials such as lead or cadmium (perovskites, PbS, CdTe and CdS(Se) or rare elements such as tellurium or indium (CdTe and CIGS(Se)/CIS. Recently, I-V-VI chalcogenide semiconducting compounds containing non-toxic and earth-abundant elements are more interesting to be studied because of their potential applications in thermoelectric and photovoltaic devices.

Silver bismuth sulphide (AgBiS2) is such a promising photovoltaic absorber material due to the suitable bang gap (Eg=~1.3 eV) and high absorption coefficient (α=~10^5 cm^{-1}). Here we report one step chemical process method to deposit polycrystalline AgBiS2 followed by heat treatment at various temperatures from 250 to 450°C and various composition ratio of Ag/Bi from 0.8 to 1.2 to form matildite cubic crystal structure of AgBis2. XRD result shows that, cubic matildite $AgBiS_2$ phase has been formed well with the cell constant of a=5.6480 Å in agreement with reported data (JCPDS Cardreference code 01-089-2045) and matildite phase is stable enough in wide range of heat treatment temperature and composition ratio of Ag/Bi without formation of any secondary phase. Moreover, among various common solvents for spin coating process such as N,N-dimethylformamide (DMF), Gamma-butyrolactone (GBL) and Dimethyl sulfoxide (DMSO), DMSO is suitable as a solvent for making spin-coated film in case of slow evaporating rate during spin-coating and low-wetting angle between solution and the substrate to achieve 100% surface coverage and preventing discontinuous and island-type layer. SEM images from the plan- and cross-section views of AgBiS2 layer show a polycrystalline thin film, deposited on the top of FTO substrate. The band gaps for AgBiS2 thin films with various composition ratio of Ag/Bi (0.8-1.2) annealed at 250°C are determined to be in the range of 1.26 to 1.38 eV which are in the range of bulk AgBiS2 band gap. In-addition, absorption coefficient measured from the samples with various composition ratios are ~2*10^5 cm^{-1} at 600 nm wavelength.


Ag/Bi=1.2
Ag/Bi=1.1
Ag/Bi=1
Ag/Bi=0.9
Ag/Bi=0.8
111
200
220
311
222
Intensity
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
10
20
30
40
50
60
70
2θ


Heat treated at 400°C
Heat treated at 350°C
Heat treated at 300°C
Heat treated at 250°C
111
200
FTO
FTO
FTO
220
FTO
311
222
FTO
FTO
Intensity
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
10
20
30
40
50
60
70
2θ



(a) Surface and (b) cross section SEM images of AgBiS2 deposited layer by chemical process.