

Role of doping on the thermal properties of porous Silicon

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Eventhough porous silicon (PS) has been extensively studied in the recent past, the study on phosphorous and boron doped porous silicon [(Si:P),(Si:B)] are rarely reported. Thermal properties of porous silicon and doped porous silicon are more important in the design of the semiconducting devices and thermal insulating layers. Hiroshi Kuwahata et al [1] have studied the dependence of carrier concentration in n-Si by photoacoustics. Blonskij et al [2] investigated the optical and thermal properties of porous p-silicon (111) formed by anodization of the wafers in 36% of HF. Ferreira da Silva et al [3] studied thermal and optical properties of porous p-silicon(100) formed electrochemically in 40% of HF:ethanol in 1:1 ratio. Here we have grown first the crystalline silicon (c-Si) and n- and p- doped silicon by Czochralski (CZ) method in the (111), (100) orientations. Preliminary investigations are carried out by XRD,IR and Raman measurements and they agree with the literature.

Photoacoustic(PA) measurements are done to start with, for thermal diffusivities (α) and conductivities (k) of crystalline silicon for different dopants and they are given in the following Table.

Thermal properties	Si:P		Si:B		Silicon (Ref 4)
	(111)	(100)	(111)	(100)	
Thermal diffusivity (cm ² /s)	0.14	0.17	0.11	0.20	0.80
Thermal conductivity (W/cm K)	0.23	0.28	0.17	0.33	1.30

It is observed from the Table that the values of α and k decrease with doping compared to crystalline silicon. Also these values decrease in (111) orientation compared to (100) orientation. This is due to additional defect introduced by interstitial oxygen in CZ grown crystal in (111) orientation and the results are discussed in terms of mean free path and multiple scattering of donors with static imperfections and electron-phonon interaction. The porous layers in the above samples are formed electrochemically in 48% of HF:H₂O:ethanol in 1:1:2 proportions for different current densities of 20,30 and 50 mA/cm² and different etching times. The α and k of porous samples are measured and the drastic decrease in the values of α and k in these samples are discussed. Now the proportion of the etching solution is varied to investigate depth of pores in the samples. The variation of depth of pores with different proportions of etching solution are analyzed and the reported results add new informations to fabricate samples of smaller α and k.

References

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