다공성 실리콘 기판위에 Plasma-assisted molecular beam epitaxy으로 성장한 산화아연 초박막 보호막의 발광파장 조절 연구

Emission wavelength tuning of porous silicon with ultra-thin ZnO capping layers by plasma-assited molecular beam epitaxy

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초

록: Porous silicon (PS) was prepared by electrochemical anodization. Ultra-thin zinc oxide (ZnO) capping layers were deposited on the PS by plasma-assisted molecular beam epitaxy (PA-MBE). The effects of the ZnO capping layers on the properties of the as-prepared PS were investigated using scanning electron microscopy (SEM) and photoluminescence (PL). The as-prepared PS has circular pores over the entire surface. Its structure is similar to a sponge where the quantum confinement effect (QCE) plays a fundamental role. It was found that the dominant red emission of the porous silicon was tuned to white light emission by simple deposition of the ultra-thin ZnO capping layers. Specifically, the intensity of white light emission was observed to be enhanced by increasing the growth time from 1 to 3 min.

1. 서론

The discovery of visible light emission from a porous silicon (PS) layer has attracted increased attention due to its potential applications in electronic, optoelectronic, and photovoltaic devices of nanoscale dimensions, such as light emitting devices, sensors, and solar cells. Thus, the abovementioned discovery has been studied to explain the fundamental mechanism of visible luminescence from a PS layer. A few passivation techniques have been reported, including high-temperature oxidation , NF_3 annealing, passivation by carbon films, andoxidizing, thermal treatment with organic molecules, and metal deposition to prevent contamination of the dangling bonds of a PS skeleton with the surrounding gas by preventing their exposure to air. In this study, PS was prepared by electrochemical anodization and ultra-thin zinc oxide(ZnO) layers were deposited onto the PS by plasma-assisted molecular beam epitaxy(PA-MBE). The growth process was performed for various times. The effects of ZnO capping layers on the emission wavelength tuning of the PS were investigated.

2. 본론

Figure 1 shows the PL spectra of the as-prepared PS and the ultra-thin ZnO capping layers on the PS with different growth times. First of all, it was found that the dominant red emission of the porous silicon was tuned to white light emission by simple deposition of the ultra-thin ZnO capping layers. Additionally, the intensity of the white light emission peak was observed to be enhanced by increasing the growth time from 1 to 3 min. The blue, green, and red emission peaks may originate from the interaction of each emission peak of the ultra-thin ZnO capping layers and PS.

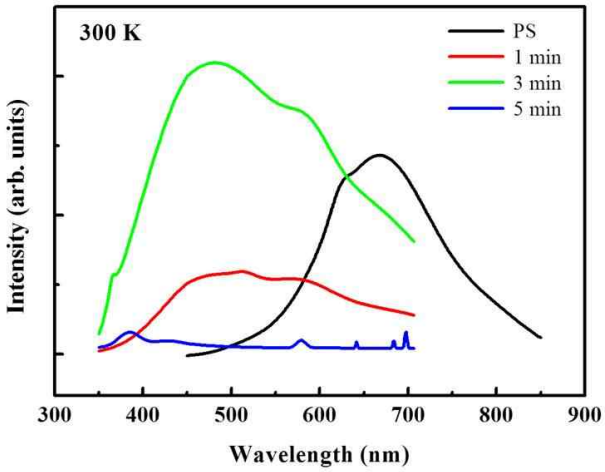

Fig. 1. PL spectrum of ultra-thin ZnO capping layers with different growth times.

3. 결론

PS was prepared by electrochemical anodization and ultra-thin ZnO layers were deposited onto the PS by PA-MBE. The layers were deposited under different growth times: 1, 3, and 5 min. The as-prepared PS has circular pores over is entire surface. Its structure is similar to a sponge where the QCE play a fundamental role. The grain size of the ZnO crystals increased with the growth time on the rough surface of the PS. For the growth time of 5 min, the ZnO crystals were clustered on the rough surface of the PS. It is found that the dominant red emission of the PS was tuned to white light emission by simple deposition of the ultra-thin ZnO capping layers. Specifically, the intensity of the white light emission was observed to be enhanced by increasing the growth time from 1 to 3 min. Additionally, the white light emission disappeared and a weak/broad NBE emission was observed for the growth time of 5 min. This occurs because the properties of the ultra-thin ZnO capping layers were dominant compared to those of the PS. Hence, the major region of peak was evidently tuned when the ultra-thin ZnO capping layers were deposited on the PS.

참고문헌

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