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Abstract
Porous silicon layers (PSL's) that produced from the constant anodization-current process were usually not thick enough to get high photo-resposivity. Furthermore, because those thin PSL's usually led to quite flat light-absorption response spectra, they were not suitable for some specific optical-sensing applications. In this dissertation, we developed graded-etching technologies to form PSL's, in which the anodization etching time and etching current were gradually changed to form different PSL's structures. Basic photodetectors were fabricated based on the as-formed PSL's in order to check the optoelectronic properties of the developed PSL's.
Compared with the constant etching current process, PSL's devices fabricated from the graded-etching current process had higher photo-responsivity. Devices made from linearly increasing etching-current process (10mA?40mA) got a peak response of 0.26A/W at 880 nm, while devices made from linearly decreasing etching-current process (40mA?10mA) got a peak response of 0.29A/W at 690 nm. Both values are respectively about 62.5% and 53% higher than those of the devices fabricated from the constant etching-current process. In the mean time, we found that the peak photo-responsivity of devices based on an increasing etching-current process tended to shift toward long-wavelength, while that of devices based on a decreasing etching-current process was toward shore-wavelength. These phenomena were supposed to be related to the different nanocrystal size distribution in the PSL's formed by the two different etching processes.
It was also found that thick PSL's (~35μm) with higher mechanical strength and more uniform pore distribution can be achieved by gradually changing simultaneously the etching time and the etching current. The preferable PSL structures produced was attributed to the modulated etching parameters in the anodization process, which might compensate the porosity gradient produced by the constant etching-current process. In addition, devices based on the modulated etching-parameter process showed a comparatively abrupt photo-response spectrum with a peak value of 0.26A/W at 880 nm. At a bias of 10V, the obtained photo-to-dark current ratio is about 90, which is 36 times larger than that got from the constant etching current process.
Experimental results verified that the graded etching technologies can produce stronger thick PSL's with uniform porosity distribution and the as-fabricated devices possessed lower dark-current, higher photo-to-dark current ratio, and more abrupt responses in the near infrared (NIR) range. These indicated that such techniques have high potential in development of highly sensitive NIR photodetectors.
Advisory Committee Kuen-Hsien Wu - advisor

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