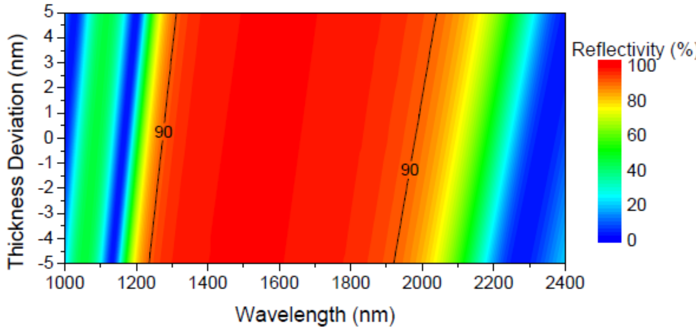

Fig. 5. Calculated reflectivity spectra and thickness deviation dependency of the five-period a-Si/a-Si DBR as a function of wavelength.

Figure 6 (a) shows a digital photographic image of the deposited a-Si/a-Si DBR shaped as the media mark of an institute. Any size or any feature of a structure can be fabricated by a simple lift-off process for the realization of a highly reflective broadband DBR suitable for various optoelectronic devices. As shown in Fig. 6 (b), the relative reflectivity of the patterned structure at 1550 nm was plainly higher than that of a normal Si (100) substrate and the superiority of the tolerant a-Si/a-Si DBR and its fabrication process are clearly evident.

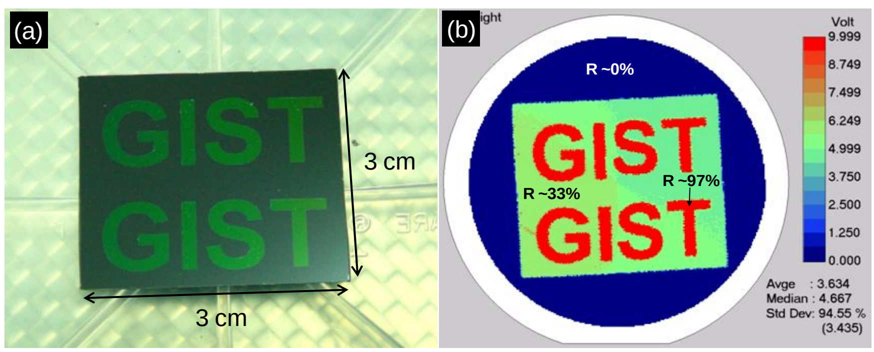

Fig. 6. (a) Photographic image of 'GIST'-patterned a-Si/a-Si DBR on Si substrate. (b) Relative reflectance mapping image of 'GIST'-patterned a-Si/a-Si DBR on Si substrate.

4. Conclusion

In summary, we proposed a novel class of DBRs based the OAD of a-Si. The reflective characteristics were investigated both theoretically and experimentally. Highly tolerant and highly reflective broadband a-Si/a-Si DBRs were demonstrated successfully for the first time. A broadband stop band ($\Delta\lambda/\lambda$ = 33.7%, R>99%) with only a five-period a-Si/a-Si DBR was achieved experimentally. The size-, feature- and substrate-independent method to realize highly tolerant and broadband DBRs will provide an interesting new pathway that opens future practical applications such as resonant-cavity-light-emitting-diodes or vertical-cavity-surface-emitting-lasers or solar cells. In an addition, oblique-angle deposition is promising for the growth of homogeneous highly reflective DBR structures with a very high refractive index contrast.

Acknowledgments

This work was partially supported by the "Systems biology infrastructure establishment grant" provided by GIST in 2011 and by the WCU program of MEST (Project No. R31-2008-000-10026-0) and by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MEST) (No. 2011-0017606).