quantum well material, here for the nonpolar quantum structures the absorption edge is at longer wavelengths, around λ~500 nm.

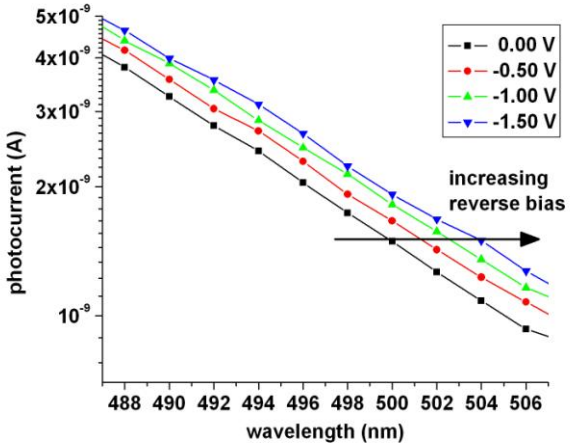

Fig. 7. Photocurrent spectra of our device based on nonpolar InGaN/GaN quantum heterostructures. The arrow indicates the red shift of the absorption edge with the increasing reverse bias.

4. Conclusion

In conclusion, we presented the opposite external electric field dependence of carrier lifetimes and optical absorption characteristics in *c*-plane grown polar *vs. a*-plane grown nonpolar InGaN/GaN quantum heterostructures. We showed using time-resolved photoluminescence measurements that carrier lifetimes decrease with increasing external electric fields in polar quantum epi-structures, whereas the opposite occurs in nonpolar quantum epi-structures. In addition, we presented the blue shift of the absorption edge in polar quantum heterostructures and the red shift of the absorption edge in nonpolar heterostructures. We explained these opposite behaviors in the context of Fermi's golden rule as well as quantum confined Stark effect.

Acknowledgments

This work is supported by EU-FP7 Nanophotonics4Energy NoE, and TUBITAK Grant Nos. EEEAG 109E002, 109E004, and 110E010. H.V.D. acknowledges support from ESF-EURYI and TUBA GEBIP, and E.S. from TUBITAK-BIDEB 2211.

#140055- $15.00USD Received 22 Dec 2010; revised 23 Feb 2011; accepted 25 Feb 2011; published 8 Mar 2011