



Fig. 6. The measured (solid squares and circles) and modeled (opened squares and circles) SFDRs depending on the RF frequency for both depletion-type and injection-type modulators.

4. Discussion and conclusion

We characterized a Si PN-diode MZI modulator under carrier-depletion and carrier-injection effects for RF photonic application. The analog performances, including slope efficiency and spurious-free dynamic range (SFDR), are measured and compared. The experiments suggest that while injection-type modulator shows an order-of-magnitude higher slope efficiency, the depletion-type modulator is usually with 20 dB·Hz^{2/3} higher SFDR at different input RF frequencies. Such measurement results are verified by numerical modeling and show good agreement.

Although the demonstrated Si MZI modulator shows relatively small bandwidth upon both depletion and injection effects, it is applicable for higher speed modulation as demonstrated by other groups previously. In general, most of the depletion-type MZI modulators are with bandwidth larger than 10 GHz [9–14], while the optimized injection-type MZI modulator can operate with ~10 Gb/s data rate [8]. Thus, in view of different analog applications, it is of importance to choose different types of modulators. For the application requiring high modulation speed (> 10 Gb/s) and high SFDR, it is better to choose the depletion-type modulator. Whereas, for the application requiring moderate modulation speed (< 10 Gb/s) and high slope efficiency, the injection-type modulator is a better choice.

Acknowledgment

This work was supported by the Science and Engineering Research Council of A*STAR (Agency for Science, Technology and Research), Singapore under SERC grant number: 102 174 0174.