UNIVERSITY OF CAMBRIDGE

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Impact of Technology Scaling Towards CMOS Electrochemical Impedance Biosensors

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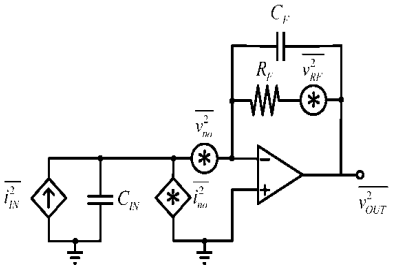
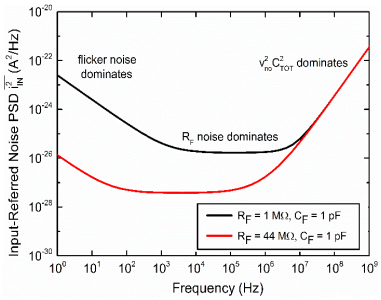
Introduction

- Noise analysis of transimpedance amplifier in CMOS electrochemical impedance biosensors is carried out.
- The device noise trend in CMOS ultra-deep-submicron (UDSM) processes is simulated and its impact on system performance is discussed.

Results and Discussions

- Noise model of transimpedance amplifier (TIA)

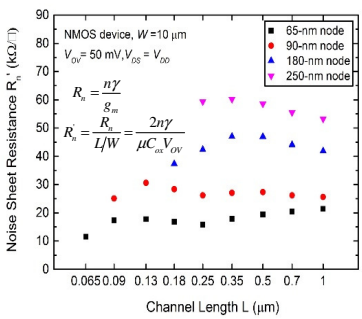


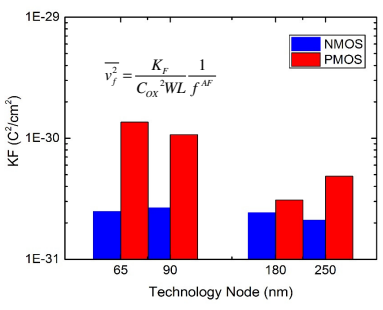


$$\overline{i_{IN}^2} = \overline{i_{no}^2} + \frac{4k_BT}{R_F} + \overline{v_{no}^2}\left(\frac{1}{R_F^2} + (2\pi f)^2(C_{IN}+C_F)^2\right)$$

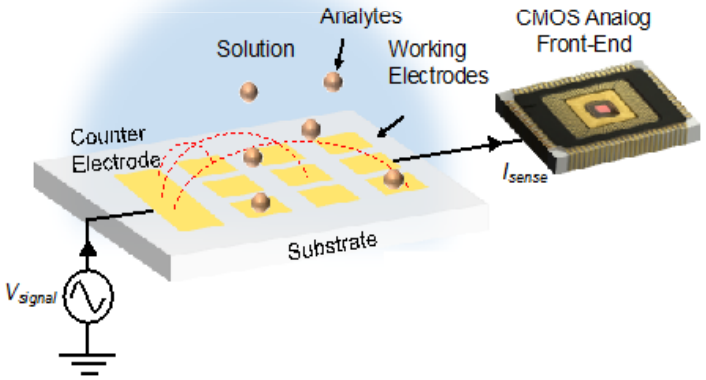
$$\approx \frac{4k_BT}{R_F} + \overline{v_{no}^2}\left(\frac{1}{R_F^2} + (2\pi f)^2 C_{TOT}^2\right)$$

- Noise performance in CMOS UDSM processes

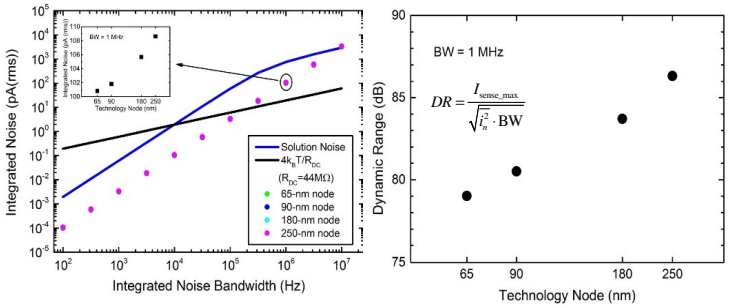




- Electrochemical Impedance Biosensors



- System noise performance and dynamic range



Conclusion

- Noise in transimpedance amplifier is dominated by feedback resistor and Opamp. Increased input capacitance boosts the noise at high frequencies.
- In terms of system noise performance, the noise is dominated by solution noise and feedback resistor. The impact of technology scaling on noise performance is negligible while the dynamic range is reduced in shorter-channel technologies due to lower supply voltage.

Related Publication: • Jiahao Li *et al.*, submitted.