

Fig. 1. Experimental data for HCI effect in the end of string. Note that threshold voltage increases as gate voltage and NOP increases by HCI effect.

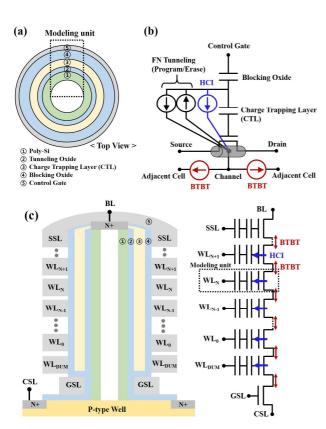


Fig. 2. Schematics for proposed modeling structure and corresponding equivalent circuit. (a) Illustration for top view of GAA structure in CTF devices and corresponding (b) single modeling unit and (c) string-level modeling unit

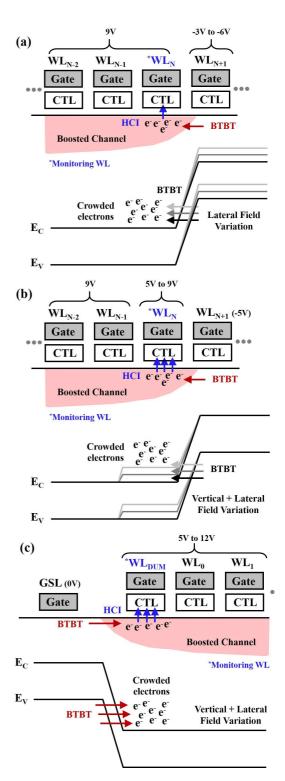


Fig. 3. Illustrations for proposed experimental method in our work. Band diagrams are used to clarify each mechanism and bias conditions and we recommend sequential progress from (a) to (c) to break down terms and extract model parameters compactly.

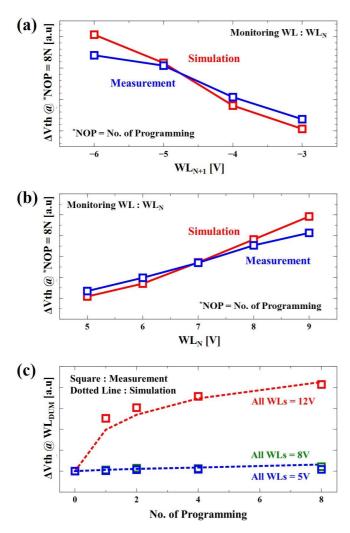


Fig. 4. Optimized results by fitting the proposed model to experimental data which we present in Fig. 3 using simulation program with integrated circuit emphasis (SPICE) simulation.