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Imagining and Imaging Future Devices: A Physicist's Dream

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In the past device scaling followed conventional Dennard scaling with recent introductions of stress to enhance mobility and high k dielectrics to reduce leakage. Future devices will initially need improved electrostatic confinement with associated geometrical complexity, mobility improvements through new materials, steeper sub-threshold slopes through bandgap engineering and 3D system integration. Eventually new state variables beyond electron charge will be necessary to provide both extremely low power and non-volatility. To enable these changes, improved atomic resolution metrology techniques for both complex 3D geometries and new state variables will be required. While there is still plenty of room at the bottom for the physics of these devices, we are more rapidly running out of room for measuring and controlling these devices. Physicists will have an increasingly important role for both imagining and imaging these devices.