Carbon Nanotube Electronics

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Motivations

Flexible, wearable & portable electronics

Overcoming non-linear effects to use bandwidth more efficiently
Carbon Nanotubes

- Mechanically flexible
- Inherently linear
- High mobility (up to 10,000 cm²/Vs)
- High current carrying capability
- Small dimension & intrinsic capacitance

Excellent materials for flexible electronics and radio-frequency electronics
Carbon Nanotube Radio-Frequency (RF) Electronics

- Self-aligned source/drain
- Aligned, high-density, ultrahigh semiconducting purity carbon nanotubes

- Well-aligned, high-density (40 tubes/μm), and ultrahigh semiconducting purity carbon nanotubes.
- Channel length: 100–150 nm.

Excellent RF Performance with High Linearity

\[ V_{DS} = -1.5 \text{ V} \]

**Drain Current (mA)**

**Gate Voltage (V)**

\[ V_{DS} = -1.5 \text{ V} \]

**V_{GS}: 0 \sim -2 \text{ V}**

**Step: -0.2 V**

**Intrinsic \( f_t \) with DDS (GHz)**

\[ \sqrt{f_t \cdot f_{max}} \text{ (GHz)} \]

**Intrinsic \( f_{max} \) with DDS (GHz)**

8 GHz & 8.3 GHz

\[ \|P_3\| = 22 \text{ dBm} \]

**Input Power (dBm)**
Carbon Nanotube Ultra-Flexible Electronics

Carbon Nanotube & IGZO for CMOS Flexible Electronics

501-stage ring oscillator

Yu Cao, et al, Nature Communications 2014, 5, 4097
Thanks for your attention!

http://nanolab.usc.edu/