**Docket #:** S11-133

# High Resolution Capacitance Bridge for Nano-structures

This patented technology is an Integrated Capacitance Bridge (ICB) that can perform ultra-high-resolution (aF), wide-temperature-range measurements of capacitance in nano-structures. The ICB has an operational range of 4K-300K and can measure at length scales 100x smaller than the current standard equipment. The ICB also uses a small excitation signal so that it can probe the electronic details of nano-scale structures without disturbing them. It can be used either as a stand-alone chip or integrated into a probe device for quality testing, measurement, or characterization of new and existing materials such as carbon nanotubes and graphene.

**Stage of Research**
The inventors have fabricated the ICB and tested it on top-gated graphene devices and carbon nanotube field effect transistors. These tests demonstrated that the ICB resolution was several orders of magnitude greater than a commercially available capacitance bridge.

## Applications

- **Nanoscale testing and measurement** of capacitance spectrum for nano-structures or materials that exhibit quantum capacitance, including:
    - characterizing new research materials (such as carbon nanotubes and graphene) in computing devices and memory
    - quality testing existing materials

## Advantages

- **Ultra high-resolution:**

    - ~10aF/rt(Hz) (orders of magnitude better than commercially available equipment)
    - data are not distorted by the large contact resistance that often exists at the interfaces of nano-scale devices
- **Wide-temperature range** - 4K-300K
- **Small excitation signal:**
    - signal amplitude smaller than kBT/q (compared to 10's of millivolts in current equipment)
    - can probe nano-devices without disturbing them

## Publications

- Joseph A. Sulpizio, Arash Hazeghi, Georgi Diankov, David Goldhaber-Gordon, H.-S. Philip Wong, "An integrated capacitance bridge for high-resolution, wide temperature range quantum capacitance measurements", arXiv:10009.5407v1, Sept. 27, 2010.

## Patents

- Published Application: 20130076378

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