

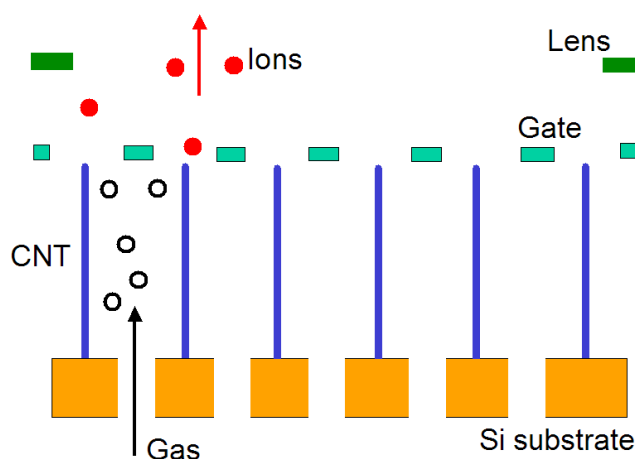
A Single-gated Open Architecture Carbon Nanotube Array for Efficient Field Ionization

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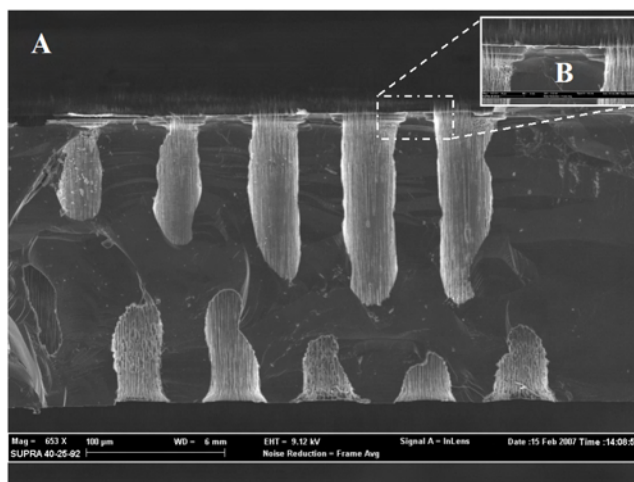
Mass spectrometers require a suitable ionizer to be able to discern the chemical composition of the sample that they are analyzing. Traditional ionizers for gases use either chemical ionization (CI) or electron impact ionization (EI). In the latter case, electrons from thermionic sources produce ions by colliding with neutral molecules. More efficient carbon nanotube-based field emitted electron impact ionizers have been developed [1]. However, one of the drawbacks of electron impact ionization is that the sample is transformed into fragmentation products. Several samples could have similar fragmentation spectra but be quite different compounds, with radically different properties (for example, one substance can be a poisonous agent while another is a harmless material). Therefore, an approach to reduce the fragmentation products would improve the informational power of the mass spectrometer.

Field ionization soft-ionizes molecules, thus reducing the fragmentation products. In the field ionization scheme, ions are created by directly tunneling electrons from the outer shell of neutral

molecules by virtue of a very high electric field [2]. The electric field is produced by high aspect ratio field enhancers and the application of a large (up to 1 kV) bias voltage. Carbon nanotubes are ideal field enhancers because of their high aspect ratio and their reduced tip radius. A good field ionizer should work in the field-limited regime instead of the molecular flux-limited regime, where all the molecules that approach the high field region are thus ionized. In the case of the electron impact ionizers, a closed architecture is implemented because it is intended to protect the field enhancers from back streaming ions [3]. Therefore, an open architecture, where the field enhancers surround a through-hole, is a more suitable approach to produce field ionization. We plan to implement a single-gated field ionizer array with an open architecture. Figure 1 shows a schematic of the open architecture concept. Figure 2 shows a cross section of the device. Current research effort focuses on device characterization.



▲ Figure 1: Schematic of a Field ionizer array. The gas inlet provides neutral species to the field enhancers. If the molecules of the gas come close enough to the CNT tips, an electron from the outer shell of the molecule will tunnel to the CNT, thus ionizing the molecule.



▲ Figure 2: A single-gated CNT field ionizer array grown at MIT. Field view of an array cross-section (A), and detail of two adjacent field ionizers (B). The ionizer well has a film of silicon dioxide 5 µm thick below the gate that acts as electrical insulator between the gate and the CNTs. The CNT catalyst was Ni 7.5 nm thick.

REFERENCES

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