

# International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI)

(An autonomous R&D centre of Department of Science and Technology, Govt. of India)  
Balapur P.O., Hyderabad – 500005, Telangana, India



## Vertically aligned Carbon Nanotubes (CNTs) for Field Emission Applications

### Overview

Over the last one decade the competing technologies of vacuum electronics devices and solid state devices have synergized to give rise to the new area of vacuum microelectronic devices. These devices exploit the motion of electronics in vacuum to get the advantages of vacuum electronics and micro fabrication technology. The basic elements of vacuum microelectronic devices are cold emission source. The present day solid state devices limited in their capabilities and the vacuum microelectronic devices appear to be promising. Extending the frequency of TWTs to millimeter range requires high current densities. Because the required beam current density is proportional to the square of operating frequency, the use of field-emission cathodes is an alternative method for delivering a high current density and direct modulation of the emitted beam is possible in FEAs. It can improve the efficiency and reduce the size of the microwave source. As they exploit the best of the both worlds of vacuum electronics and solid state fabrication technology. Carbon Nanotubes field emitter arrays are preferred for use in vacuum microelectronic devices.

### Key Features

- Large aspect ratio (>1000) and Atomically sharp tips
- Low work function.
- High electrical and thermal conductivity.
- High temperature and chemical stability.
- Very high current carrying capacity –  $10^{10}$  A/cm<sup>2</sup>
- Excellent mechanical properties

### Potential Applications

- Flat Panel Display
- Amplifiers
- Electron Source
- Emission Triode
- Cathode Source X-Rays

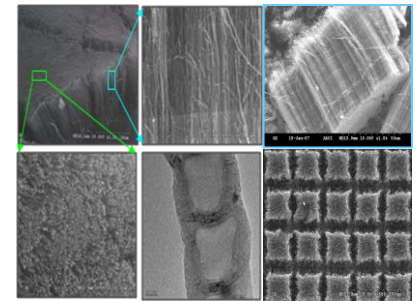
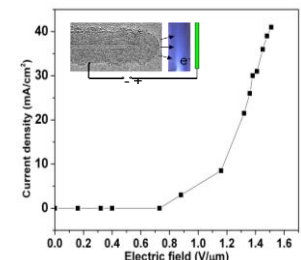


Image of Vertically Aligned CNTs with bamboo type structures & patterned CNTs islands

### Intellectual Property Development Indices (IPDI)

- Vertically aligned carbon nanotubes (CNTs) were developed by CVD Process
- Controlling the microstructures i.e. bamboo type & the Nitrogen content
- Patterning the Aligned CNT through micromachining by Laser



Field Emission Properties of ARCI CNTs  
(40 mA/cm<sup>2</sup>)

Status	1	2	3	4	5	6	7	8	9	10
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### Major Patents/Publications

- Influence of N doping concentration on morphology & microstructure of N-doped super aligned CNTs arrays  
*J. Advanced Microscopy Research*, 8, 300-304, 2013.
- Nitrogen incorporated highly aligned carbon nanotube arrays thin film grown from single feed stock for field emission  
*Journal of Nanoelectronics and Optoelectronics*, Vol. 8, 1-5, 2013
- Self Organized growth of bamboo like carbon nanotubes arrays for field emission properties  
*Applied Nanoscience* (2012) 2:253-259
- Synthesis of Vertically aligned CNTs Arrays by Injection method in CVD  
*Journal of Nanoscience and Nanotechnology*, Vol. 10, pp 4960- 4966 (2010)

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