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# CAT BeamTech

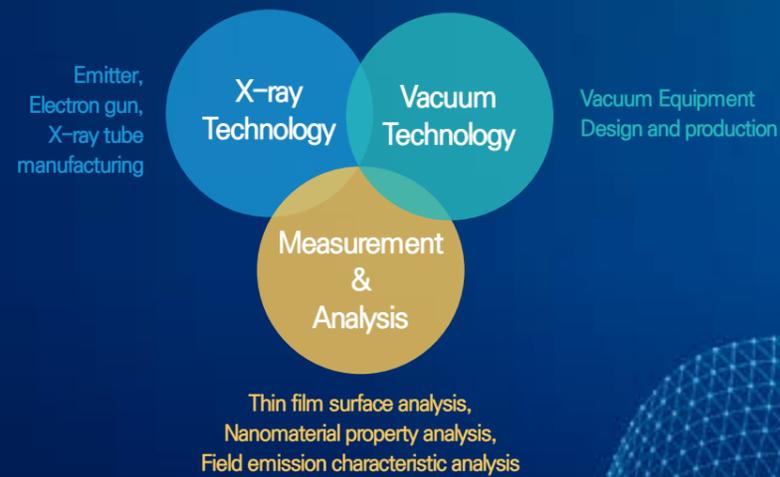
A company specialized in CNT based  
compact X-ray system



# CAT BeamTech

Established in 2017, CAT Beam Tech Co., Ltd. is a startup which develops a next-generation X-ray system based on technical knowhow and original ideas.

CAT Beam Tech's flagship product; Digital X-Ray Tube, is a product that combines performance and durability by applying an unique direct growth type CNT Emitter as a core component. In addition, we have vacuum equipment consulting technology for development of various customized emitters, electron guns, and X-ray tubes.



## Vision

### Slogan

NEW X-RAY,  
NEW PARADIGM

### Vision

A company specialized in  
CNT based compact X-ray system

## History

- 2017 ..... Establishment of CAT Beam Tech Co.,Ltd.
- 2018 ..... Filament X-ray tube(dental) launched, Established US Subsidiary
- 2019 ..... CNT X-ray tube(industrial and dental) launched
- 2020 ..... Relocation of new office building and received GMP facility(ISO 13485) certification
- 2021 ..... CNT X-ray tube for medical purpose launched
- 2022 ..... CNT-based X-ray system expected to be launched

# Directly grown Carbon Nanotube Technology

The directly grown carbon nanotube is a vital for X-ray tubes based on field emitters.

At CAT Beam Tech, we have developed a process to directly grow CNTs using Chemical Vapor Deposition (CVD) process. Our CNT manufacturing method is a revolutionary method that enables rapid and accurate manufacturing of electron emission sources of various sizes and performances by selectively growing it on a designed substrate.

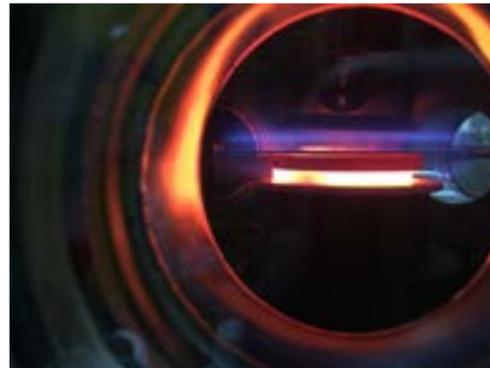
## ◆◆ PECVD Process

**Method** Using a mixture of  $C_2H_2$  /  $NH_3$  gases, CNTs are grown on top of Ni seeds on Silicon substrate with help of plasma.

**Features**

- Vertically aligned growth
- Ease of selective growth
- Controlled CNT growth
- Control the number of CNTs

**Target** High performance product line



## ◆◆ TCVD Process

**Method** Using mixture of  $C_2H_2$  /  $NH_3$  gases, CNTs are grown on metallic substrate at  $\sim 900^\circ C$ .

**Features**

- Randomly grown CNTs
- Easy to grown on Large area
- Easy to customize and design
- Simple and efficient process

**Target** Basic product line



# X-ray tube Production Process

At CAT Beam Tech, we design and manufacture high quality electron emission sources, customized electron guns and durable X-ray tubes .

We have not only improved the reliability of performance through step-by-step performance test of emitters, electron guns, and X-ray tubes, but also built a mass production system through a manufacturing process using digital control.



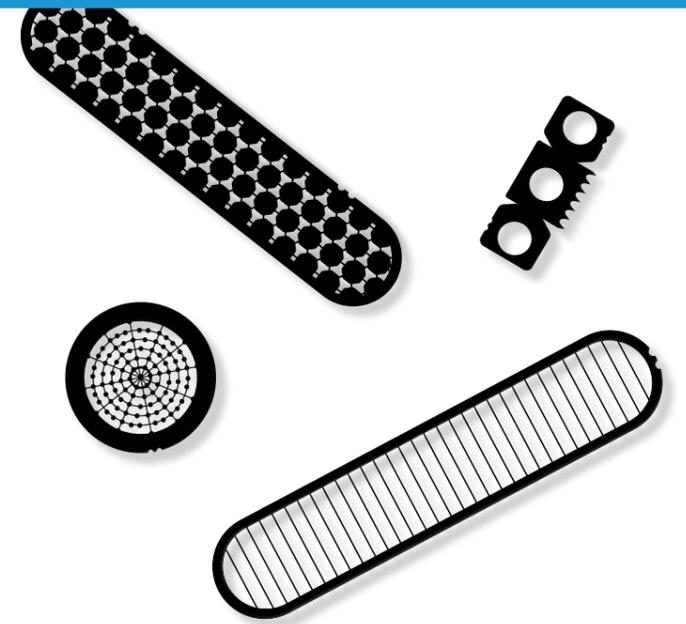
# Carbon Nanotube CNT Emitter

Carbon nanotube emitters are synthesized directly on metal or silicon substrates by decomposing mixed gases ( $C_2H_2$ ,  $NH_3$ ) with energy such as heat, electric field, and plasma.

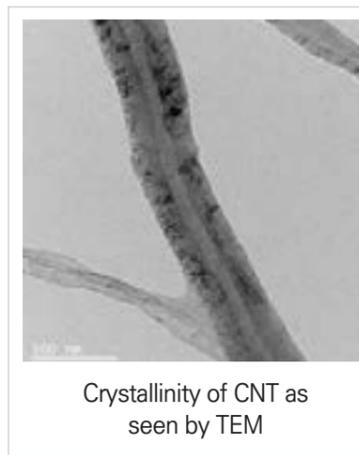
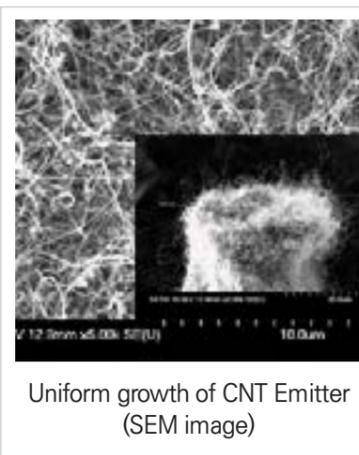
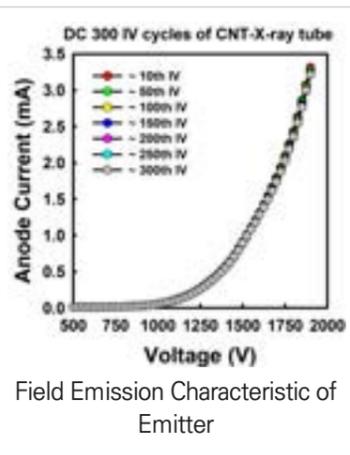
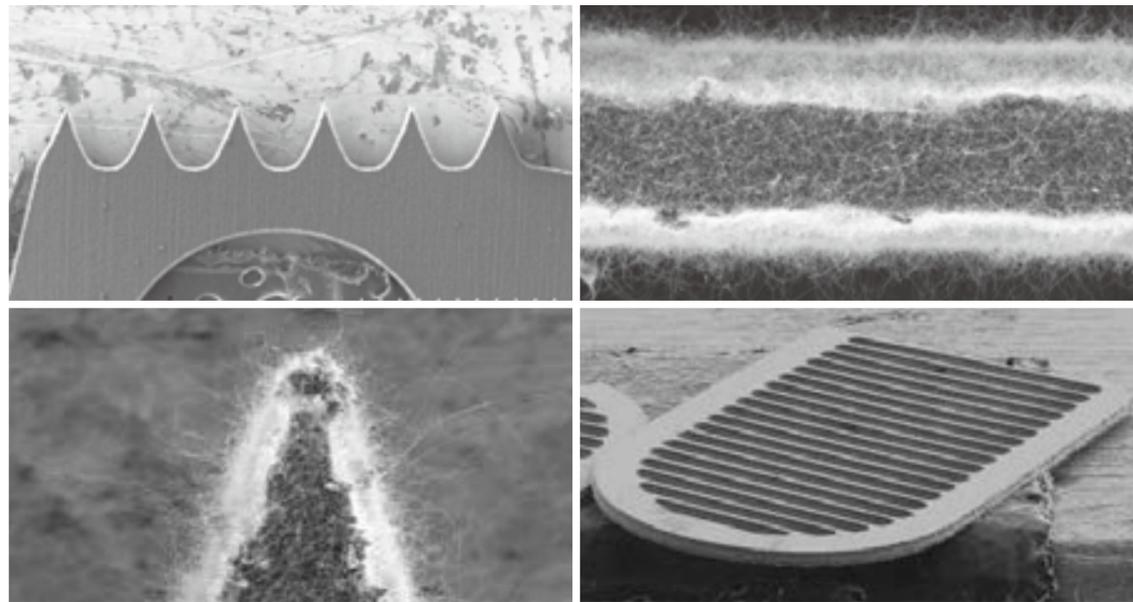
CAT Beam Tech's directly grown carbon nanotube emitter is not only excellent in field emission characteristics, but also can be manufactured in various forms, making it an optimized product for X-ray electron emission sources.

## Feature

- ✓ Direct growth using CVD method
- ✓ Customized growth on various substrates
- ✓ High reproducibility
- ✓ Excellent field emission performance



## SEM Images of Emitter



## Specification

### ES-100A



Dimension (W x H x T, mm)	Substrate Type (Material)	Substrate Area (cm <sup>2</sup> )	Emission Area (cm <sup>2</sup> )	Manufacturing Method	CNT Height (μm)	Max. Current (mA)
8 X 2 X 0.1	Ni alloy	0.274	0.1377	TCVD	100~200	10

### EH-100A



Dimension (W x H x T, mm)	Substrate Type (Material)	Substrate Area (cm <sup>2</sup> )	Emission Area (cm <sup>2</sup> )	Manufacturing Method	CNT Height (μm)	Max. Current (mA)
8 X 2 X 0.1	Ni alloy	0.274	0.21	TCVD	100~200	10

### ER-060A



Dimension (W x H x T, mm)	Substrate Type (Material)	Substrate Area (cm <sup>2</sup> )	Emission Area (cm <sup>2</sup> )	Manufacturing Method	CNT Height (μm)	Max. Current (mA)
∅5 X 0.1	Ni alloy	0.28	0.157	TCVD	100~200	6

### EV-200A



Dimension (W x H x T, mm)	Substrate Type (Material)	Substrate Area (cm <sup>2</sup> )	Emission Area (cm <sup>2</sup> )	Manufacturing Method	CNT Height (μm)	Max. Current (mA)
01 x 8 x 2	Ni alloy	0.054	<0.01	TCVD	100~200	20

# Electron Gun

We have a wide range of product lines by developing our own technology of cold cathode type electron gun with carbon nanotube emitter and hot cathode type electron gun with filament.

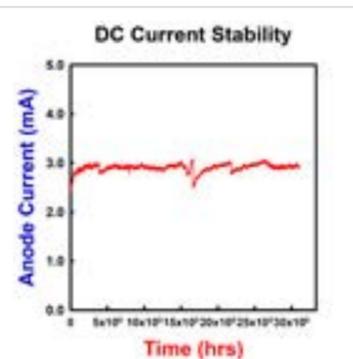
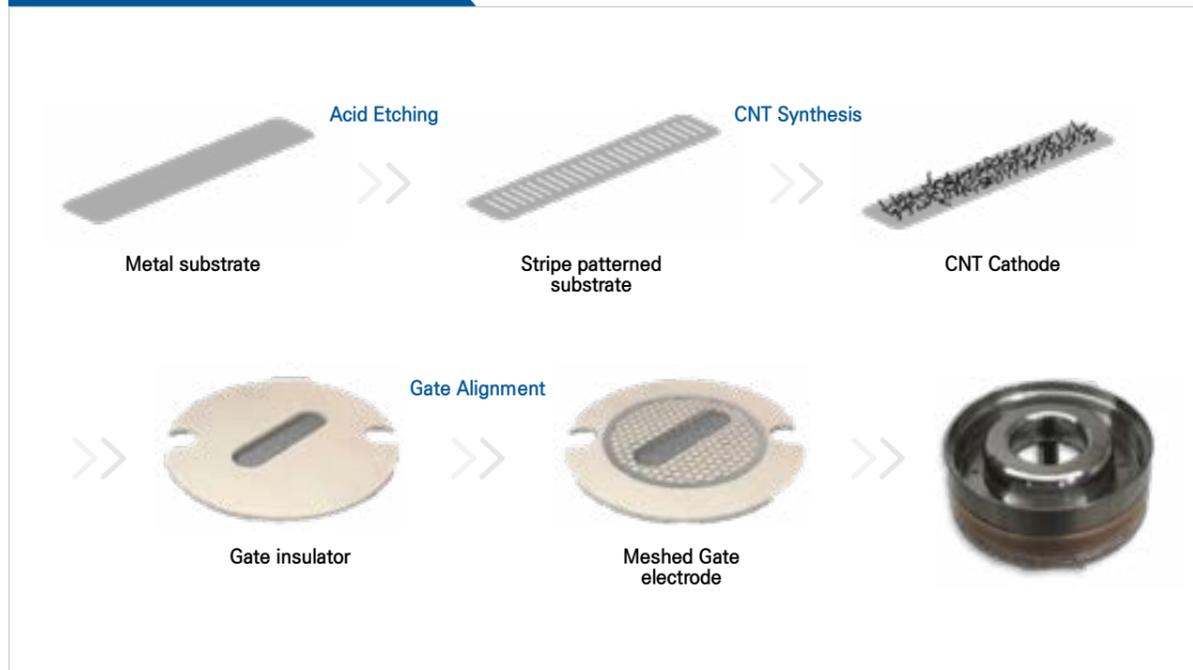
CAT Beam Tech's carbon nanotube electron gun has self-focusing structure with less than 15% gate leakage loss when operated in triode mode.

## Feature

- ✓ Low Leakage Ratio (<15%)
- ✓ Focusing electrode control function (<0.1mm)
- ✓ Multi-array configuration
- ✓ Customized production



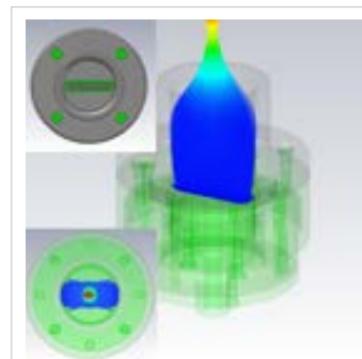
### Electron gun manufacturing process



DC field emission Stability



Gate structure with minimal current loss



Field emission Simulation

## Specification

### GC-030A



Dimension (W x H x T, mm)	Electron emission source	Leakage ratio (%)	Max. Current (mA)	Operating Range (mA)
φ5~19	CNT	10~15	3	0.3~2

### GF-100A



Dimension (W x H x T, mm)	Electron emission source	Leakage ratio (%)	Max. Current (mA)	Operating Range (mA)
φ16~27	CNT	10~15	10	0.5~5

### GM-100A



Dimension (W x H x T, mm)	Electron emission source	Leakage ratio (%)	Max. Current (mA)	Operating Range (mA)
18 X 6 X 2	CNT	10~15	10~100	1~7

### GF-900A



Dimension (W x H x T, mm)	Electron emission source	Leakage ratio (%)	Max. Current (mA)	Operating Range (mA)
φ27	Filament	-	100	1~100

# X-ray Tube

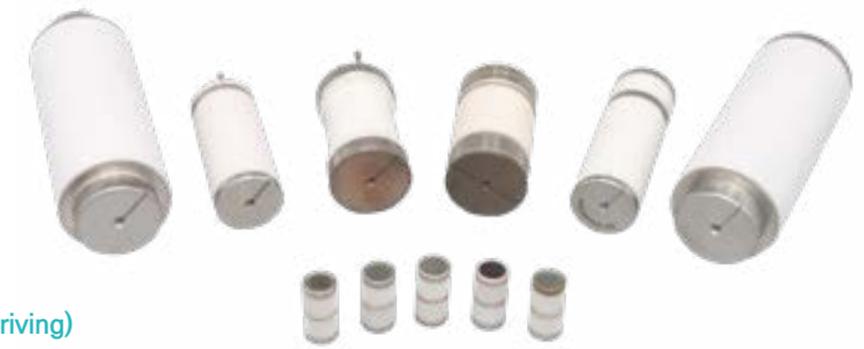
The core technology of CAT Beam Tech lies in the digital X-ray tube based on Carbon Nanotube field emission technology.

Digital X-ray tube is a high vacuum enclosed ceramic tube manufactured at a low pressure of  $10^{-7}$  torr. It is optimized for digital driving and can be applied to various products.

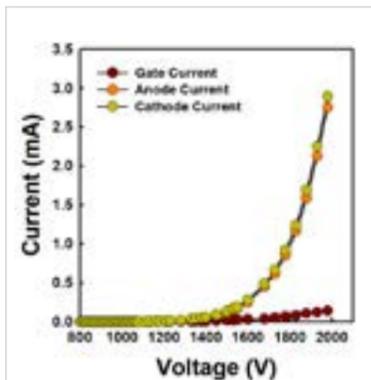
Based on years of experience of CAT Beam Tech's engineers, it can be customized according to the customer's needs. In addition, the tube body is made with ceramic to enhance its robustness and durability compared to conventional glass.

## Feature

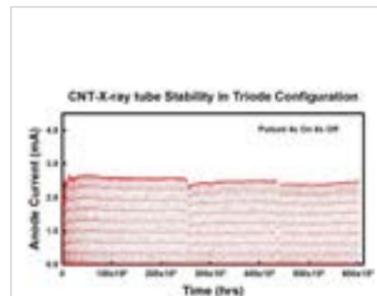
- ✓ Ceramic body
- ✓ Stationary anode
- ✓ Triode Configuration
- ✓ Reduction of radiation (digital driving)
- ✓ Customized production



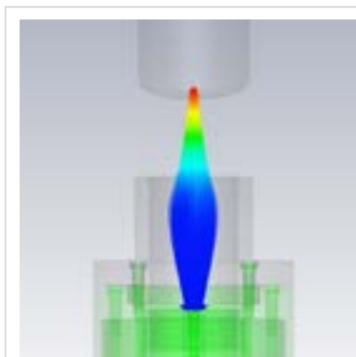
### X-ray tube manufacturing process



70kV 3mA tube I-V characteristic



216,000 shot Test



Controlled Focal spot Technology

## CNT Tube Lineup

### TC-070B



Dimension(mm)	Weight(g)	Tube Type	Anode Voltage(kV)	Max. Current(mA)	FSS(mm)
∅22×65	92.5	CNT Ceramic Sealed tube	~70	~4.0	0.3

### TC-090A



Dimension(mm)	Weight(g)	Tube Type	Anode Voltage(kV)	Max. Current(mA)	FSS(mm)
∅27×58	118.7	CNT Ceramic Sealed tube	~90	~10	0.5

### TC-120B



Dimension(mm)	Weight(g)	Tube Type	Anode Voltage(kV)	Max. Current(mA)	FSS(mm)
∅35×103.5	306.5	CNT Ceramic Sealed tube	~120	~15	0.8

## Filament Tube Lineup

### TF-070B



Dimension(mm)	Weight(g)	Tube Type	Anode Voltage(kV)	Max. Current(mA)	FSS(mm)
∅22×65.5	92.1	Filament Ceramic Sealed tube	~70	~4.0	0.3

### TF-090A



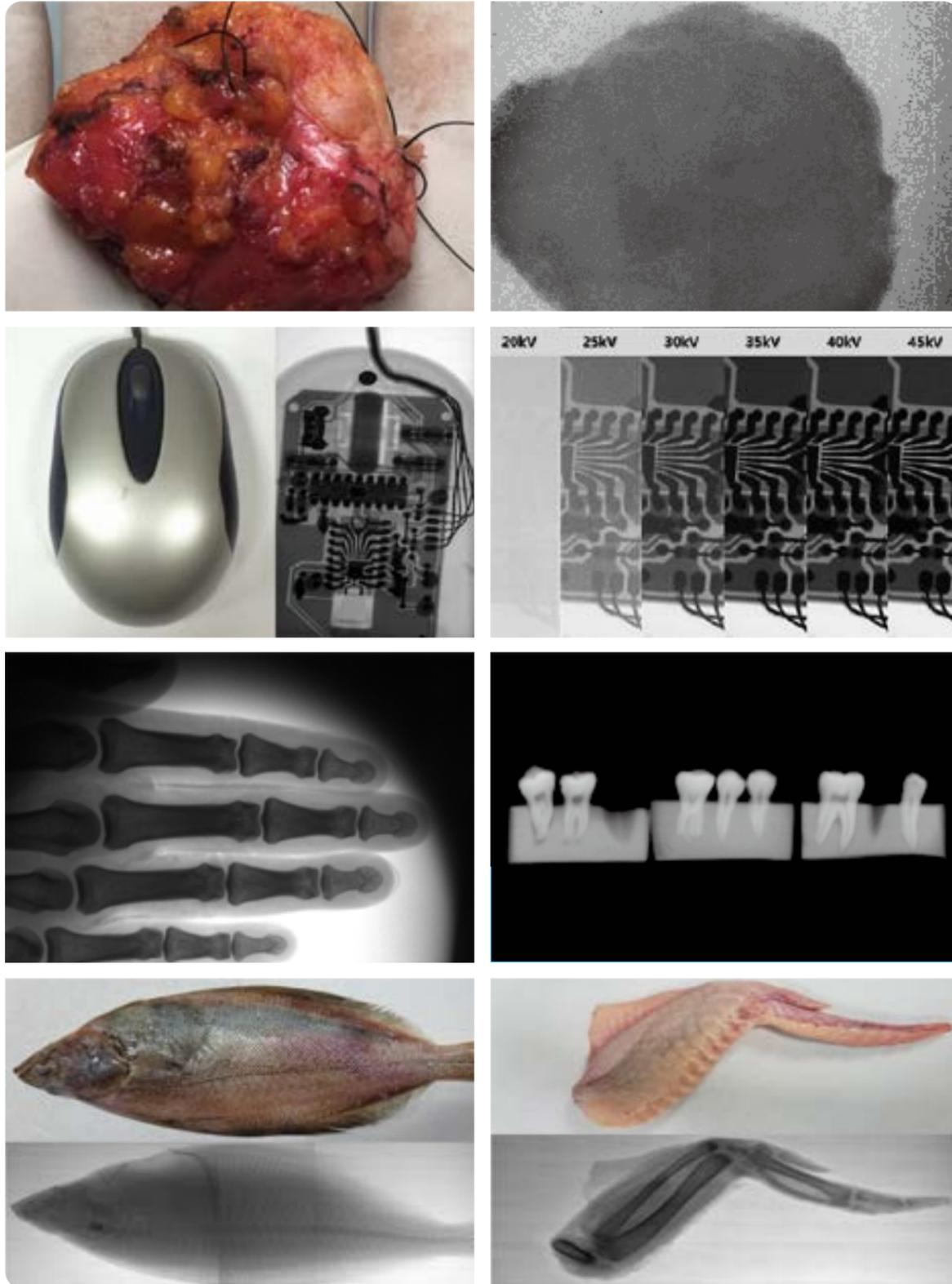
Dimension(mm)	Weight(g)	Tube Type	Anode Voltage(kV)	Max. Current(mA)	FSS(mm)
∅27×70.6	131.2	Filament Ceramic Sealed tube	~90	~10	0.5

### TF-120B



Dimension(mm)	Weight(g)	Tube Type	Anode Voltage(kV)	Max. Current(mA)	FSS(mm)
∅35×102	331.5	Filament Ceramic Sealed tube	~120	~15	0.8

# X-ray Images



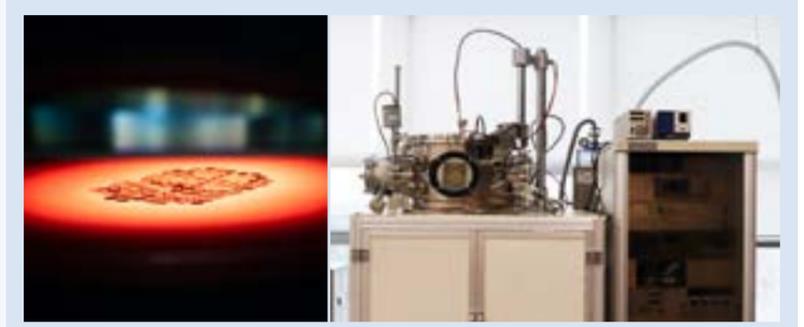
# Facility

01

## Emitter Production

CVD System

—  
Electron emitter  
fabricating  
using CVD process



02

## Pre-treatment of parts

High Temperature  
Vacuum Furnace

—  
Cleaning and degassing of  
parts using heat treatment



03

## E-gun·Tube Production

Brazing System

—  
Electron gun/ tube  
manufacturing using  
metalceramic  
brazing process



04

## Product performance inspection

Quality Control Process

—  
Driving test and inspection of  
electron gun and X-ray tube



# Patent



DIGITAL X-RAY SOURCE  
(Patent No. US 9,728,367 B2)



X-RAY SOURCE INCLUDING  
POINT SOURCE TYPE EMITTER  
(Patent No.10-1145531)



A SINGLE-TYPE MULTI ARRAY  
X-RAY SOURCE MODULE  
(Patent No.10-1501842)



DIGITAL X-RAY SOURCE  
(Patent No.10-1701047)



APPARATUS FOR INTERGRAL  
DIGITAL LIGHT SOURCE  
(Patent No.10-1749858)



DIGITAL X-RAY TUBE  
(Patent No.10-1752997)



LIGHT SOURCE DEVICE  
(Patent No.10-1768769)



ELECTRON EMISSION SOURCE  
UNIT AND DIGITAL X-RAY SOURCE  
(Patent No.10-1862939)



APPARATUS FOR DIGITAL LIGHT  
SOURCE  
(Patent No.10-1876076)



X-RAY TUBE AND  
MANUFACTURING METHOD THEREOF  
(Patent No.10-2092368)



DUAL X-RAY SOURCE UNIT AND  
DUAL X-RAY APPARATUS  
(Patent No.10-2131665)



EMITTER MANUFACTURING  
METHOD AND PROCESSED EMITTER  
(Patent No.10-2149750)



ELECTRON EMISSION AND X-RAY  
APPARATUS HAVING THE SAME  
(Patent No.10-2264672)



EMITTER AND ELECTRON EMITTING  
SOURCE HAVING THE SAME  
(Patent No.10-2358244)



X-RAY TUBE  
(Patent No.10-2358246)



EMITTER FOR X-RAY TUBE AND  
MANUFACTURING METHOD THEREOF  
(Patent No.10-2358259)



ELECTRON EMITTING ELEMENT  
AND MANUFACTURING METHOD  
THEREOF (Patent No.10-2358284)

# CAT BeamTech

"We make next-generation X-rays that are safer and faster"

Specialized in CNT based compact X-ray system

CAT Beam Tech, a leading company in the field of next generation radiation

## Collaboartors

### Medical Institution



Asan Medical Center

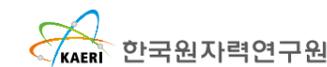


Samsung Medical Center



Kyung Hee Medical Center

### Research Institute



Korea Atomic Energy Research Institute



Kyung Hee University



Konkuk University