CSIR - Central Electronics Engineering Research Institute (CSIR-CEERI)
Pilani-333 031 Rajasthan, India
www.ceeri.res.in

Area of Research: Microwave Devices

CSIR-CEERI has been keeping pace with the recent developments and created a standard for the microwave research in the country. It has not only earned recognition in India but also globally. Research efforts and devices development at the institute have placed our country in the elite group of advanced nations. The area has four research teams namely, beam dynamics, beam-wave interaction, device technology, and vacuum microelectronic devices. It has excellent scientific manpower and research facilities to design and develop various kinds of microwave and mm-wave (THz) vacuum of plasma based devices. Several microwave devices like magnetrons, travelling wave tubes (TWTs), klystrons, power triodes, carcinotrons, gyrotrons, and dispenser cathodes were designed, developed and delivered to user agencies such as DRDO (Ministry of Defence), Department of Atomic Energy (DAE), ISRO (Department of Space), SAMEER (MeitY), etc. Recently microwave devices area is also venturing into 5G mission with major contribution in mm-wave technologies. CSIR-CEERI has entered into MoUs with TEC and C-DoT

Some Technological Breakthroughs over the Years

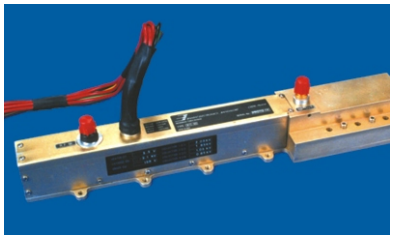
6 MW S-band klystron

- 5 MW pulsed S-band klystron for RRCAT, DAE
- 3 MW pulsed S-band magnetron for BARC (DAE)
- 2.6 MW pulsed S-band magnetron for SAMEER, MeitY
- 25 kV/1 kA hydrogen thyratron for RRCAT, DAE
- 35 kV/3 kA thyratron for BARC (DAE)
- 42 GHz, 200 kW gyrotron for IPR, DAE
- 6 MW pulsed S-band klystron for BARC, DAE
- C-band 60 W space TWT for ISRO
- 140 W Ku-band space TWT for ISRO
- Thermionic emission microscope for cathode emission studies
- High-power RF couplers for BARC, DAE
- Mercury-free plasma UV lamp (MFPUV Lamp) for water purifiers
- Large volume penning discharge source for IPR, DAE
- Triple alloy coating for electronic emission of cathodes for MTRDC, DRDO

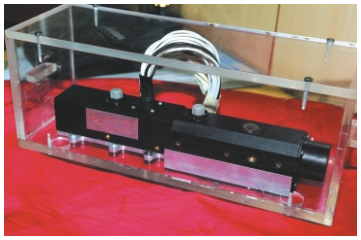
25 kW/1 kA hydrogen thyratron

42 GHz gyrotron

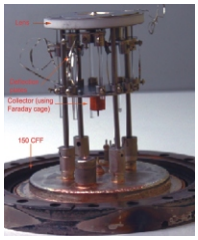
MFPUV-Lamp in a water purifier



C-band 60 W space TWT



140 W Ku-band Space TWT



Thermionic emission microscope

3 MW S-band magnetron

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Area of Research: Cyber-Physical Systems

CSIR-CEERI has been immensely contributing to the growth of electronics in addressing the societal needs of the country. The research teams comprised of cognitive computing, IoT, signal analytics, power electronics, control and automation, and integrated systems. Major contributions of this area have been the development of indigenous TV technology; electronic instrumentation for Indian Railways, sugar industry, paper & pulp industry, tea industry, and mining industry; aquaculture, synthetic milk detection, specialised high-voltage pulsed & CW power systems, wireless sensor networks, image processing based systems, NIR-based chemometric systems, IoT, intelligent manufacturing, etc. A major activity in this area has been a special manpower development programme for VLSI design, supported by the government of India . The institute is running MTech programme, Integrated Dual Degree PhD (IDDP) and PhD programme in Advanced Electronics Engineering under AcSIR.

Some Technological Breakthroughs over the Years

TV technology demonstration at Prime Minister's residence

Control system testing on a Locomotive

Withering trough automation at Gulma Tea Estate

- First Indigenous know-how for black & white television
- Excitation control system for Indian Railways - More than 4000 diesel locomotives were fitted with the control system
- Electronic control system for sugar industries - More than 300 sugar mills were instrumented in the country
- Withering trough automation system for tea industry
- 1000 W IoT enabled smart solar tree installed at CSIR-CEERI, Pilani
- Electronic instrumentation for mining industry
- Plastic waste sorting system for 5 types of plastic
- Automatic sorting machine for mangoes for internal defects
- Electronic control system for community RO plants
- Ksheer scanner/ksheer tester for detection of adulteration in milk
- PWM amplifier and control electronics for actuators for DRDO
- 5 HP solar pump drive for pumping applications

Sensors and transmitters for sugar industry

IoT enabled smart solar tree

Ksheer scanner/tester for detection of adulteration in milk

Plastic waste sorting machine

Mango sorting machine

RO plant automation system

Solar pump drive

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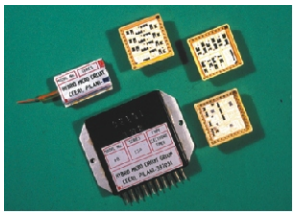
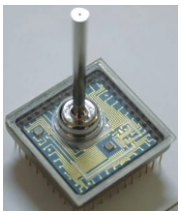
Research Area: Smart Sensors

CSIR-CEERI has excellent research facilities for design and fabrication of microcircuits. Research teams in the area are nano bio-sensors, transducers and actuators, optoelectronics and MOEMS, flexible and non-silicon electronics, advanced electronic packaging and process technologies. A number of semiconductor devices were designed, developed and delivered to user agencies like Department of Atomic Energy (DAE), ISRO (Department of Space), Ministry of Defence, etc. The institute is running MTech programme, Integrated Dual Degree PhD (IDDP) and PhD programme in Advanced Electronics Engineering under AcSIR.

Some Technological Breakthroughs over the Years



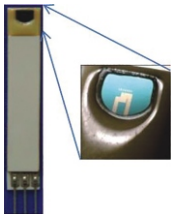
Hybrid microcircuits for satellites



LTCC pressure sensor module

MEMS gas sensor

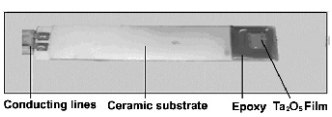
Lab-on-a-Chip (LOC) for particles separation and counter



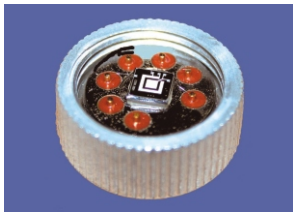
Thick-film alumina packaged pH sensor

- Hybrid microcircuits for ISRO-SROSS and INSAT series of satellites
- MEMS acoustic sensor for launch vehicles (ISRO)
- Silicon carbide Schottky diode detectors for BARC, DAE
- MEMS based gas-sensor platform for NH_3, H_2S, VOCs, etc
- High power GaAs MESFET for ISRO
- 980 nm pump laser diode for optical communication
- InGaAs/InP PIN photodetectors
- Optical power splitter for WDM and FTTH applications
- Integrated optical receiver for optical communication
- Microwave circuits using LTCC technology for ISRO
- RF MEMS switches for ISRO
- Capacitive micromachined ultrasonic transducer for IGCAR, DAE
- ISFET device for pH sensing under NPMASS
- MEMS vibratory gyroscope for strategic applications
- Mixed signal circuits for instrumentation applications
- MEMS-based piezoresistive pressure sensor for strategic applications
- MEMS-based accelerometer for strategic applications for BEL, Ministry of Defence
- LTCC micro-heater-based gas sensing platforms for SSPL, DRDO
- Lab-on-a-chip for particle separation and counter

Optical power splitter

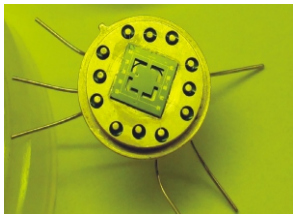


Thick-film alumina packaged EGFET device

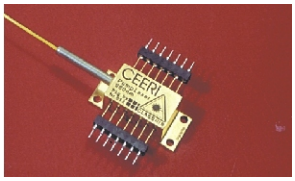


MEMS acoustic sensor for Chandrayaan, ISRO

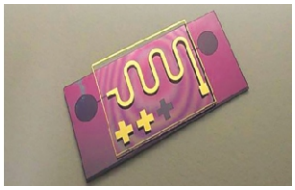
SiC Schottky diode



MEMS accelerometer



Pump laser module



Micro viscometer

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CSIR-CEERI: An Introduction

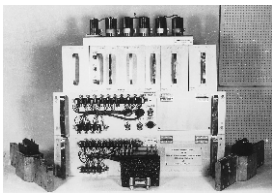
CSIR-CEERI is a constituent establishment of CSIR and one of the premier research institutes in the country. The institute was established in 1953 for the advancement of research and development (R&D) in the field of electronics. CSIR-CEERI has played a significant role in the advancement and growth of R&D in the research areas of cyber-physical systems, microwave devices and smart sensors. The institute has excellent R&D facilities and dedicated research staff to carry out the state-of-the-art research. It also offers services of consultancy, industrial training, and training for academic faculty and PG students. The institute has research extension centres at Chennai, Jaipur and New Delhi. There are three other groups to oversee and execute R&D facilities, skill development and societal outreach activities.

The institute also conducts post graduate and research programmes under the aegis of AcSIR in Advanced Electronic Systems, Advanced Semiconductor Electronics, and High Power Microwave Devices and Systems Engineering.

Areas of Research

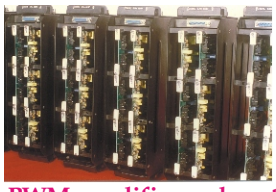
- **Research Area: Cyber-Physical Systems**
  Research Programmes being pursued: Cognitive computing, IoT, signal analytics, power electronics, control and automation, and integrated systems (Includes VLSI design)
- **Research Area: Microwave Devices**
  Research Programmes being pursued: Beam dynamics, beam-wave interaction device technology, vacuum microelectronic devices. The programmes are chiefly engaged in high-power microwave tubes including magnetrons, klystrons, gyrotrons, travelling wave tubes (TWTs), high emission density cathodes, and plasma-based devices
- **Research Area: Smart Sensors**
  Research Programmes being pursued: Nano bio-sensors, transducers and actuators, opto-electronics and MOEMS, flexible and non-silicon electronics, advanced electronic packaging, and process technologies

Cyber-Physical Systems



Excitation control system for Indian Railways

pH control system for sugar industry



PWM amplifier and control electronics for NSTL, DRDO

Microwave Devices

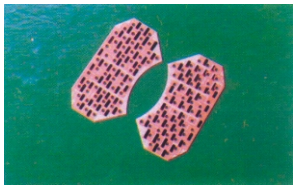
S-band 500 kW magnetrons for Navy & Air Force

5 MW S-band klystron for DAE

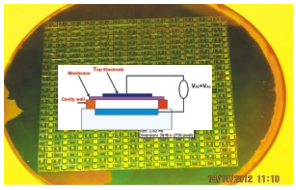
2.6 MW S-band magnetron for SAMEER

Smart Sensors

Digester control system for paper industry



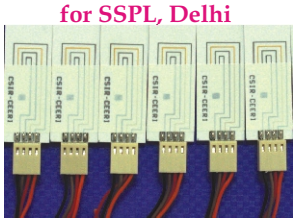
Alumina bias circuit board for SSPL, Delhi



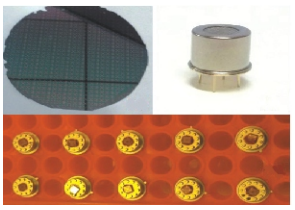
Ultrasonic transducer for DAE

2 MW S-band magnetrons for DAE

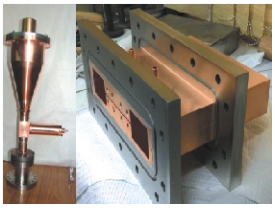
DC drive for mining locomotive



Electrodes for milk analyser



MEMS gas sensor devices



RF couplers for DAE

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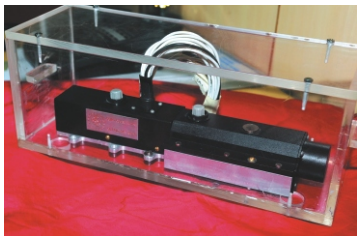
Some Technologies in Progress

System for Detection of Adulteration in Milk (Ksheer Scanner and Ksheer Tester) and Rapid Milk Analyser

Ksheer Scanner and **Ksheer Tester** technologies for detection of adulterated milk, developed at CSIR-CEERI, have been transferred to M/s Alpine Technologies, Surat (Gujarat). Earlier, the technology of Ksheer Scanner has been transferred to M/s Rajasthan Electronics and Instruments Limited (REIL), Jaipur and they have produced more than 200 systems. These electronic tongue technologies have been developed on voltammetric principle. A recent addition to the series of the products is **Rapid Milk Analyser** for measuring milk contents.

Dr. Harsh Vardhan, Minister of Science & Technlogy and Earth Sciences and Vice President, CSIR dedicated the technologies to the nation on February 20, 2016 at New Delhi.



140 W Ku-band Short-length Space Travelling Wave Tube (TWT) for ISRO

CSIR-CEERI has developed an indigenous microwave power module version of helix TWT for SAC, IRSO for their INSAT/G-SAT programmes. This makes the country self-reliant in the high technology area of satellite communication.

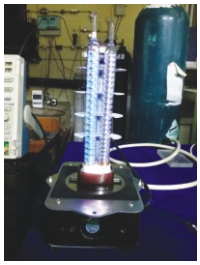
Material Discrimination using Dual-energy X-ray Imaging System

CSIR-CEERI has developed a material discrimination technique based on the atomic number and density of scanned items using dual-energy X-ray images. This technology has been successfully transferred to M/s Krystalvision Image Systems Private Limited, Pune.

42 GHz, 200 kW/Long pulse Gyrotron for IPR, DAE

A high-power microwave vacuum tube has been developed at CSIR-CEERI by a consortium of five institutes (CSIR-CEERI, IPR, SAMEER, IIT-Roorkee and IIT-BHU). The technology will have a critical role in building nuclear fusion reactors indigenously. India is now among few countries in the world (like USA, Russia, Germany, Japan and China) to have this technology. The device has been currently installed at IPR, Ghandhinagar for further testing.

Air Purifier



CSIR-CEERI has developed a Mercury-free plasma UV-lamp based advanced photocatalytic oxidation (APO) system and its performance has been tested better than the commercially available APO systems. The technology has been developed for indoor air purification and deodorisation in collaboration with M/s Vital Hospitality Private Limited, Trivandrum and it is under evaluation for transfer.

Ammonia Gas Sensor

A metal-oxide-based ammonia gas sensor along with interface electronics has been developed at CSIR-CEERI. The sensor system finds applications in monitoring of washroom hygiene and industrial pollution, etc. The technology has been transferred to M/s Macwin India Private Limited, New Delhi.

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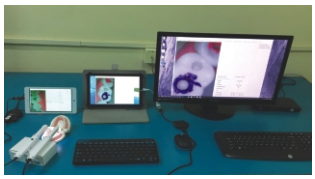
Fast Track Translational (FTT)

The following technologies are available for Transfer of Technology (ToT) under the Fast Track Translational (FTT) Projects initiated in CSIR-CEERI as per the concept created by our DG, CSIR. These technologies are developed in a given time frame.

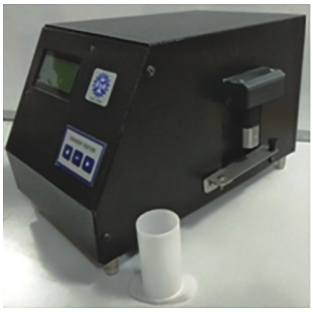
Technologies Ready for ToT



2D/3D Dental Endoscope

- 3D rigid and flexible endoscopes for denture examination
- Silent killer gas detector using LTCC technology

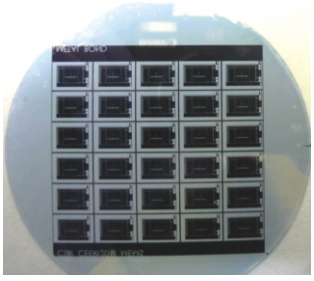
Gas sensor for environmental monitoring



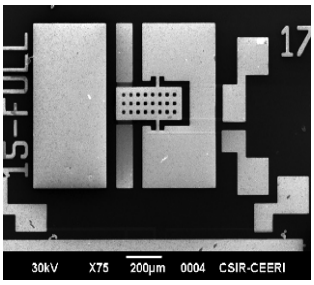
PRADUMN unit

- Prevention of adulteration in milk-a real-time remote milk supply chain monitoring network
- High frequency RF MEMS capacitive switches
- MEMS-based accelerometer
- Handheld milk quality analyser
- Gas sensor for environmental monitoring

Ksheer tester hand-held milk quality analyser



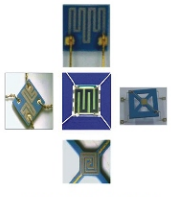
Fabricated accelerometer



RF MEMS capacitive switches

Thick Film Integrated Heating Machine for Mosquito Repellent

Thick Film Integrated Warm Shoe Insole



Different Versions of Thick Film Hotplate

Thick Film Integrated Microfarming Unit

Thick Film Integrated Hot Knife

Thick film hotplate and hotplate integrated products