

Combating COVID-19 Through Innovations and Implementation of Safety Measures



**INTERNATIONAL ADVANCED RESEARCH CENTRE
FOR POWDER METALLURGY & NEW MATERIALS (ARCI)**

(An autonomous R&D Centre of Department of Science and Technology, Govt. of India)

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Overview

Corona pandemic has impacted the world and triggered a global social and economic crisis, and science through invention and innovation holds the key to fight against this outbreak. International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), an autonomous R&D Centre of Department of Science and Technology, Govt. of India has undertaken various initiatives and measures towards its fight against the Corona Pandemic.

➤ Devices and Disinfectant to contain Covid-19

ARCI developed following devices and prepared disinfectants to contain the spread of the COVID-19 both solely and in collaboration with industry and academia:

1. UV disinfection **Trolley** for disinfection of hospital spaces
2. UVC-based multipurpose **disinfection cabinet** for containing surface contamination
3. **Sanitization chamber** for disinfecting PPEs and human body
4. Ceramic Honeycomb Based **Device for Thermal Disinfection** of PPEs
5. **Automatic Sanitizer Dispenser System & Auxiliary Pedestal System** for Biometric Attendance Machine (in-house use)
6. **Hand sanitizers** for police personnel on duty during COVID-19 crisis

➤ Innovations and Projects

Apart from the above, ARCI in collaboration with industry is also exploring development of a) Mineral paints for combating Covid-19 and b) Disinfection System for Currency Notes based on Ultra Violet C (UVC) Radiation c) Copper based disinfectant device for indoor air cleaning. Project Proposal on 'Development of self-disinfecting nanoparticle and electrospun coatings on face masks and medical suits for Combating COVID-19' has been approved for funding by NanoMission.

ARCI entered into the following Memorandum of Understanding (MoU)s with industry and academia to develop systems and technologies to combat COVID-19:

- With Saffrongrid Limited, Hyderabad to co-develop 'Human Disinfection System (HDS)' for COVID-19 (1st May 2020)
- With University of Hyderabad and Mekins Industries Limited (MIL) Hyderabad for 'Development of UVC based Disinfection System for COVID-19' (4th May 2020)
- With Innomet Advanced Materials Pvt. Ltd. Hyderabad for 'Developing a self-disinfecting paint namely Photocatalyst-assisted Copper-based Mineral Paint in view of the COVID-19 Pandemic' (8th May 2020)



MoU signing with Mekins Industries Limited



MoU signing with Innomet Advanced Materials Pvt. Limited

➤ **Measures Taken In-House for Prevention of COVID-19 Outbreak**

To ensure safety of staff at work place and to contain the COVID-19 outbreak, precautionary measures as per the guidelines are being strictly implemented. A Standard Operating Procedure (SOP) for organization is made and Do's and Don'ts displayed at the gates and other prominent locations. Masks were made available to all the employees and in addition, face shields were provided to security personal as they are likely to come in contact with more people. Wearing masks and thermal scanning for detecting body temperature abnormalities have been made mandatory for everyone entering the campus. Hand sanitizers and hand

wash liquids are provided at appropriate locations. Sanitisation of the premises including toilets, corridors, door handles etc. with sodium hypochlorite solution is carried out on a daily basis. In addition, ARCI has also approached Central Warehousing Corporation for sanitization of the premises.

To avoid transmission of virus through direct contact, an Auxiliary Pedestal System was developed and fitted to the Biometric (IRIS) Attendance punching machine at ARCI. An automatic non-contact sanitizer dispenser unit (prototype model) using IR sensor was also designed and fabricated at ARCI and a working model has been commissioned at ARCI to assess the regular functionality. Detailed standard operating procedures have also been laid down for use of ARCI bus and canteen facilities.

Complete record of entry and exit timings of personnel visiting the campus is maintained. Travel passes were arranged with local police for essential services. Visitors to ARCI are asked to download and use Aarogya Setu app before visiting ARCI. Given the scarcity of hand sanitizers in the market during the initial phase of the pandemic and as a part of ARCI's social responsibility also, ARCI produced hand sanitizers as per the WHO standards and distributed it to the police personnel in Hyderabad



A Brief Description of Devices and Disinfectants to Contain Covid-19

1. UV disinfection Trolley for disinfection of hospital spaces

ARCI, Hyderabad and University of Hyderabad (UoH) together with the help of Mekins Industries Ltd. (MIL), Hyderabad have developed a UVC based disinfection trolley to fight against COVID-19 by rapid cleaning of hospital environment.

UV light in the range of wavelength between 200 and 300 nm is capable of inactivating microorganisms, such as bacteria and viruses, thus disinfecting both air and solid surfaces. **Often, chemical disinfectants are not enough to remove the bacteria and viruses found in hospitals and other contamination prone environment.** While the recovery rates of COVID-19 patients are impressively high in India, rapid decontamination of the used patient-care beds and hospital rooms before admission of subsequent occupants, is a major requirement in hospitals in view of limited availability of beds. Coronavirus is sensitive to UVC light as in the case of other virus and bacteria. The germicidal effects of UVC irradiation with a peak intensity at 254 nm result in cellular damage of the virus thereby inhibiting cellular replication. Unlike chemical approaches to disinfection, UV light provides rapid, effective inactivation of microorganisms through a physical process.

The UVC disinfection trolley (Height 1.6m x Width 0.6m x Length 0.9m) co-developed by ARCI, UoH and MIL consists of 6 UVC germicidal tubes, which are arranged in such a way that 3 sides are illuminated with 2 tubes facing each direction. While these lamps take care of disinfection on the walls, bed and room air, the floor disinfection is carried out by 2 smaller UV lights located at the bottom facing the floor. The hospital rooms get disinfected when the trolley is moved around in the room by an operator in protective suit and UV resistant goggles. On an average, the operator moving the UVC trolley system with an average speed of

5ft/min can cover a room of 400 sq. ft. within 30 minutes for complete (>99%) disinfection.



UVC disinfection Trolley

The present system is a first prototype and is readily usable in hospitals and railway coaches that are also being planned for treatment of COVID-19 patients. Systems with smaller dimensions and further automation are in progress in view of the rapid disinfection required in aircraft cabins. The present system has been deployed (along with standard operating procedure and safety instructions) at Employees' State Insurance Corporation (ESIC) hospital in Hyderabad for field trials. The UV-light disinfection system must be operated in unoccupied rooms, after the patient is discharged and in the absence of health personnel.

2. **UVC-based multipurpose disinfection cabinet for containing surface contamination**

ARCI, Hyderabad and MEKINS Industries Limited (MIL), Hyderabad have co-developed a UVC-based Cabinet for disinfecting non-critical hospital items,

laboratory wear and PPEs in the research laboratories to prevent surface contamination of COVID 19.

It can also be used to disinfect items exhibited to customers in commercial establishments and several domestic items.

India was successful in controlling the spread of COVID 19 caused by SARS COV2 virus during the first few phases of lockdown due to strict implementation of COVID 19 guidelines. But, with relaxation of the lockdown, there is a chance of slow spread of disease due to the movement of people across the country and this is predicted to continue for some time. Transmission through surface contamination is an unpredictable risk in which common utilities play a key role.

The best way to deal with this transmission is by a dry and chemical-free rapid disinfection through exposure to UVC light. **UVC irradiation with 254 nm is strongly absorbed by RNA part of COVID-19 leading to molecular structural damage via a photodimerization process and thus inactivating it.** UVC exposure is the best known among the methods to disinfect virus-prone objects including stethoscopes, blood pressure measuring equipment, patient care items, mobile phones, wallets, laptops, laboratory reusable gloves, lab coats, micropipettes, smaller measurement equipment, papers and so on. As the extent of disinfection is proportional to the UVC dose received by a contaminated surface, designing a UVC system with proper engineering is very critical to get best results.

A compact UVC disinfection cabinet co-developed by ARCI and MIL, a Hyderabad based company, consists of 4 UVC lamps of 30W (on sides) and 2 lamps of 15 W (top and bottom). It gives a flux sufficient to disinfect articles of various dimensions placed in shelves separated by metal grided frames to allow sufficient light from all sides. For the safety consideration and to avoid direct exposure of UVC light to the user, the lamps switch on only when the door is locked. The irradiance intensity is measured at various points within the box to assure sufficient radiation to disinfect all the placed articles within 10minutes. The partition frames in the cabinet are removable so that even bigger objects like lab coats, blazers, suits can be disinfected when required. The UVC cabinet is

multifunctional and very promising for establishments including research and academic institutes, corporate offices, hospitals, clinics, nursing homes, hotels, restaurants, commercial outlets and domestic usage for fighting COVID 19.

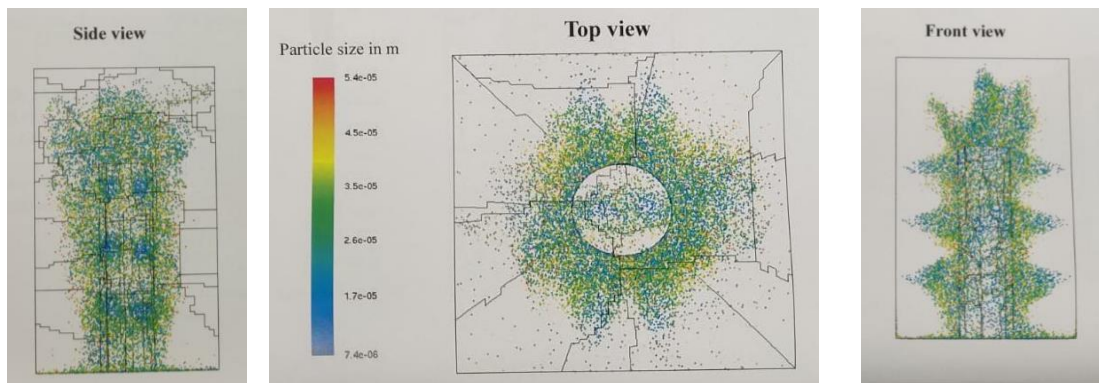


UVC-based multipurpose disinfection cabinet

3. Sanitisation chamber for disinfecting PPEs and Human Body

The doctors and frontline health workers are more susceptible to get infected with Corona virus during the current pandemic. Even though, wearing masks and washing of hands as per the WHO recommendations are practised, there is always a possibility that the protective cloths worn by the doctors and hospital workers carry the virus. In order to eliminate the spread of virus through the above mentioned accessories, sanitisation of the people with personal protective equipment (PPE) entering and exiting the hospitals is essential to minimise the spread of virus. ARCI, embarked on designing 'Sanitising Chambers' for disinfecting the medical personnel wearing PPE kits in partnership with Defence Research and Development Laboratory (DRDL), Hyderabad and ESIC Medical College and Hospital, Hyderabad. ARCI partnered with Saffrongrid, Hyderabad for product development, fabrication and assembly.

The Sanitising Chambers are installed and demonstrated at ESIC Medical College and Hospital to study its efficacy in sanitisation of PPEs and humans. The sanitisation system consists of 3 chambers of 1.5 m x 1.5 m x 2 m each wherein water is sprayed in first chamber, Hypochlorous acid (HOCl) of 50-100 ppm concentration is be sprayed in the second chamber and hot air is blown in the third chamber. Complete design of the chamber including dimension, material of construction and HOCl concentration details were provided by ARCI. Simulation studies for the optimisation of pressure, nozzle size and number of nozzles was carried by DRDL. Efficient hot air blowers based on ceramic honeycombs were made by Sowbal Aerothermics, Hyderabad. Testing of sanitisation chambers and efficacy of HOCl as a disinfectant is being carried out by ESIC Medical College and Hospital.



Simulation study shows that disinfectant is sprayed completely on the human body

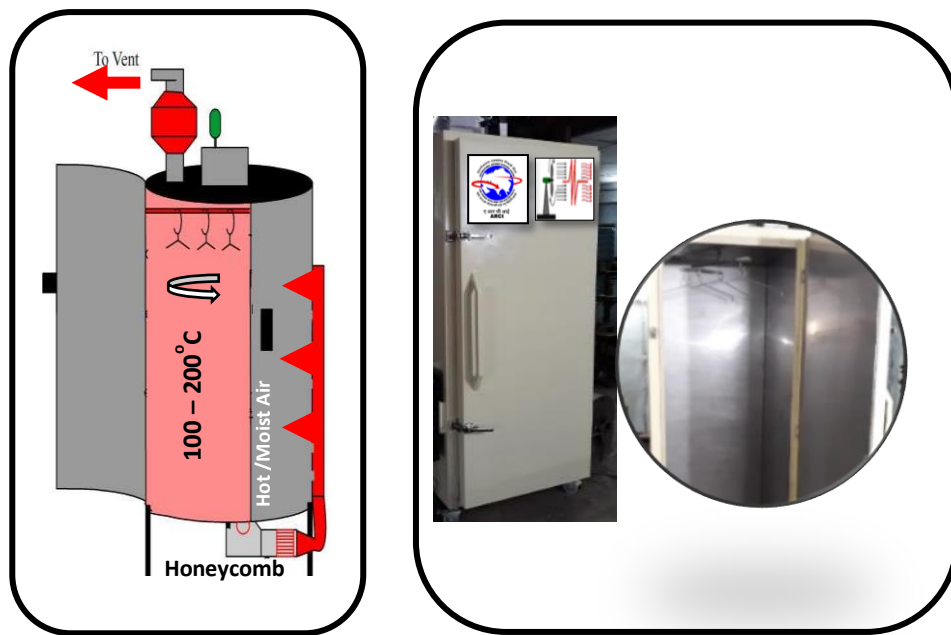


Sanitisation Chambers

4. **Ceramic Honeycomb Based Device for Thermal Disinfection of PPEs**

A unique and innovative energy efficient heat-based disinfecting device is jointly developed by ARCI and Sowbal Aerothermics, Hyderabad for the quick disinfection of microbe/virus infected PPEs and for exploring the possibility of re-use. According to recent studies (Lei Liao et.al, ACS Nano, www.acsnano.org), heating is considered as the best and efficient method for COVID19 virus disinfection of PPEs including N95 masks. Heat based disinfection process is advantageous as it does not use any volatile organics or radiations and is expected to be effective for disinfection as the heat penetrates through-out bulk of the PPEs. 'ARCI developed know-how on extrusion shaping of ceramic materials into honeycomb structures' combined with 'expertise of industrial partner Sowbal Aerothermics in directing the dry/moist heat through honeycomb channels with high efficiency' are the key factors that make system energy efficient. The device is designed to produce dry/moist heat over a wide range of temperatures and relative humidity. The major advantages of the device are as follows:

- ✓ Portable, light weight and compact
- ✓ Generation of heat instantly due to low thermal inertia honeycombs
- ✓ Easy to assemble and install and operate.
- ✓ Operable at temperatures 50°C – 150°C due to the unique heater design
- ✓ Post treatment up to 500oC to further disinfect the air before letting into the atmosphere
- ✓ Environment friendly as it does not use toxic chemical or radiations
- ✓ Highly flexible in design for dry temperature and humidity assisted disinfection
- ✓ Reduced risk of infection
- ✓ Re-use of expensive PPEs



Schematic of the Device for Thermal Disinfection and the first prototype

The disinfection devices based on this unique technology (Patent Application No.- 202011020124) are envisaged to have a very long heater life thus minimizing downtimes and also can be tailored into user-friendly models ensuring safety operations with various power ratings and relative humidity suiting to various disinfection needs. The prototype is ready for testing and evaluation for its disinfection capabilities.

5. **Automatic Sanitizer Dispenser System and Auxiliary Pedestal System at ARCI**

In order to avoid contact based bacterial/viral transmission, a) an Automatic Non-Contact Sanitizer Dispenser unit and b) an Auxiliary pedestal system for biometric punching system were designed and fabricated at ARCI for in-house use.

Automatic Non-Contact Sanitizer Dispenser

This in-house developed sanitizer dispenser unit is primarily made up of IR proximity sensor module, submersible mini water pump, Arduino Nano board, relay module (transistor or MOSFET also can be used), 6V Battery pack (4 x

1.5V each) / (adapter can also be used). When the user places his/her hands within the proximity of the sensor, the infrared energy fluctuates instantaneously and causes the IR module output to change its logical state and energizes a relay contact which in turn actuates the pump motor to dispense the liquid. Arduino Nano board is programmed to control the amount of liquid to be dispensed and to avoid the hysteresis between switching. As the liquid is automatically dispensed without any physical contact of the hand to any part of the nozzle, a hygienic environment is assured.



Automatic Non-Contact Sanitizer Dispenser

The designed system can incorporate approximately one litre of sanitizer. Further, the unit can be attached to a wall mount stand for easy access. The following advanced features were also incorporated in the dispenser system so that maximum benefits can be reaped with the help of Microcontroller programming in combination with simple hardware:

- A pre-set amount of liquid is dispensed each time to minimize wastage
- When a hand is placed under the nozzle of the dispenser, an LED and buzzer (optional) shall turn ON to indicate liquid dispensation
- LED turns ON to indicate the need for liquid refill in advance
- Even if hands remain under the nozzle, liquid dispensing can be optionally restricted by setting the duty cycle with ON and PAUSE time (in seconds).
- Arduino Nano controller permits addition of other user driven functions depending upon the place of installation, number of persons accessing, frequency of utilization etc.

Auxiliary Pedestal System

An Auxiliary Pedestal System (APS), a feet operated device, was conceptualized, developed and fitted to the biometric (IRIS) attendance punching machine at ARCI, to avoid direct hand contact with the biometric machine for height adjustment.

APS functions as an electrical foot switch (that opens or closes an electrical circuit) and is connected to the scan motor of the IRIS attendance punching machine that adjusts the height to focus the IRIS camera. This system



Auxiliary Pedestal System

starts to operate when someone steps on the actuator which in this case is the pedal. APS offers hands-free operation of the IRIS attendance punching machine, thus ensuring hygiene.

6. Hand sanitizers provided to police personnel on-duty during COVID 19 crisis

Considering the scarcity of hand sanitizers in the market, ARCI produced hand sanitizer as per the WHO standards and distributed it among police personnel in Hyderabad, students, and staff of the institution. A team of scientists, students, and staff voluntarily came forward and produced about 40 liters of sanitizer.

The complete idea of production, packaging, and distribution was completed in just 6 hours. Meanwhile, the order of lockdown was announced, and many of the students were leaving for their home towns. For their safety, a bottle of hand sanitizer and a face mask were given to most of them who were traveling. The sanitizer was also distributed to all the security staff, people working in the canteen, scientists, and also placed at common areas and entry gates. Team spirit, desire to contribute in disaster management, care, and concern about the ARCI family made this possible within a very short time.

Subsequently, given the risk being taken by the police personnel who are working relentlessly to enforce the social distancing, ARCI Director Dr. G Padmanabham

directed the team to increase the preparation of sanitizer so that it can be distributed among them. Accordingly, a substantial quantity of sanitizer was prepared and handed over to Shri Sunpreet Singh, DCP, Rachakonda Commissionerate by ARCI's Senior Scientist Dr. R. Vijay.

The Deputy Commissioner of Police, while appreciating the support extended by the scientists, requested for more quantity to provide for as many personnel as to possible. ARCI has made all arrangements to produce large quantities of sanitizer and provide it in easy-to-dispense 100 ml bottles, which the police personnel can easily carry with them in their pockets. Each bottle could last more than a week for each police personnel.

Dr. Padmanabham conveyed his appreciation to all the team members, who contributed to this effort and encouraged them and other scientists to come up with more ideas to fight COVID 19.

In order to stop the spreading of dangerous corona virus, it is recommended that hands, staircase railings, door handles, "IRIS" biometric machine keys, common equipment, office vehicles are to be cleaned by sanitizer.



The team, which had made 40 liters hand sanitizer within a few hours



Dr. R. Vijay handing over the hand sanitizer bottles made at ARCI to Shri Sunpreet Singh, DCP, Rachakonda Commissionerate

