

Since 1959



Technological Advancements for Achieving Water Sufficient GPs

T. Pradeep

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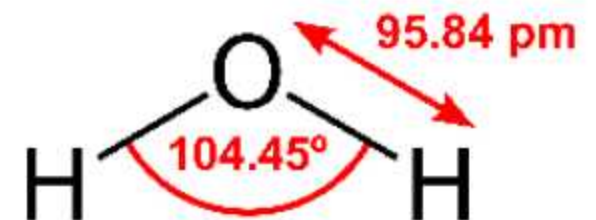
<https://pradeepresearch.org>

Rekha Yadav, Joint Secretary
Ministry of Panchayati Raj

Professor-in-charge



International Centre for Clean Water



Water is at the centre of action



Variety and diversity are part of water, in problems and opportunities



“Pale blue dot” Voyager 1 Feb. 14, 1990

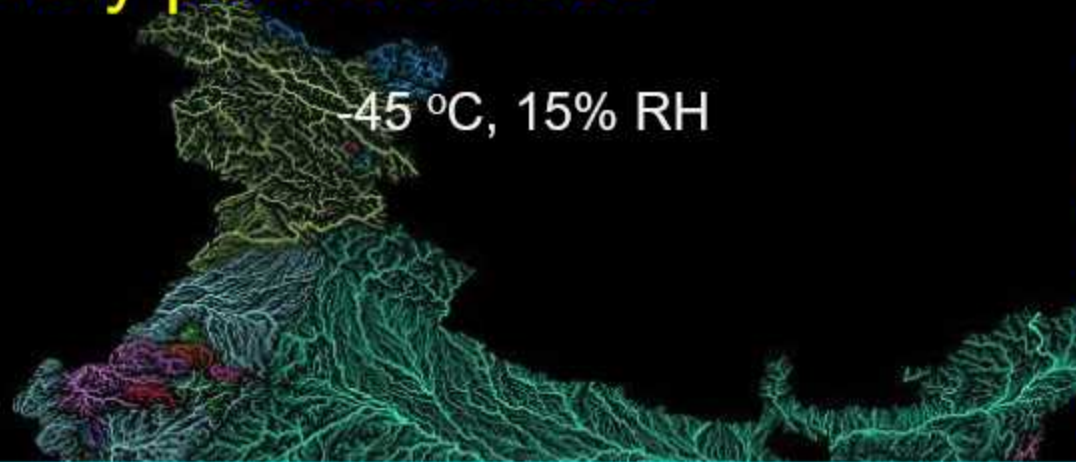
Water is the most important inheritance of our planet

Challenges

We have every possible need

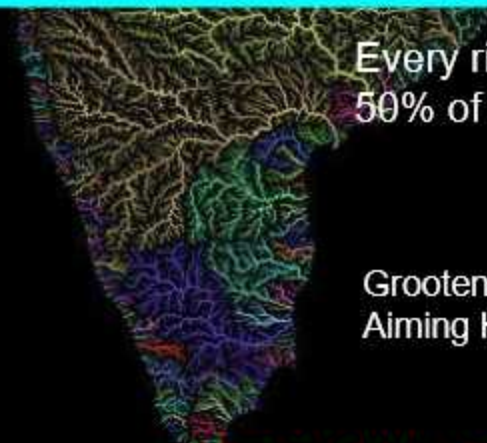
Arsenic
Fluoride
Uranium
Mercury
Chromium
Perchlorate
Nitrate
Pesticides
Antibiotics
Plastics

-45 °C, 15% RH



Issues of sustainability are paramount for villages
Villages need advanced technologies

Every river is contaminated
50% of the microbial diversity is lost for ever



Grooten, M.; Almond, R. E. A. Living Planet Report - 2018:
Aiming Higher; WWF: Switzerland, 2018.

From S. Vishwanath

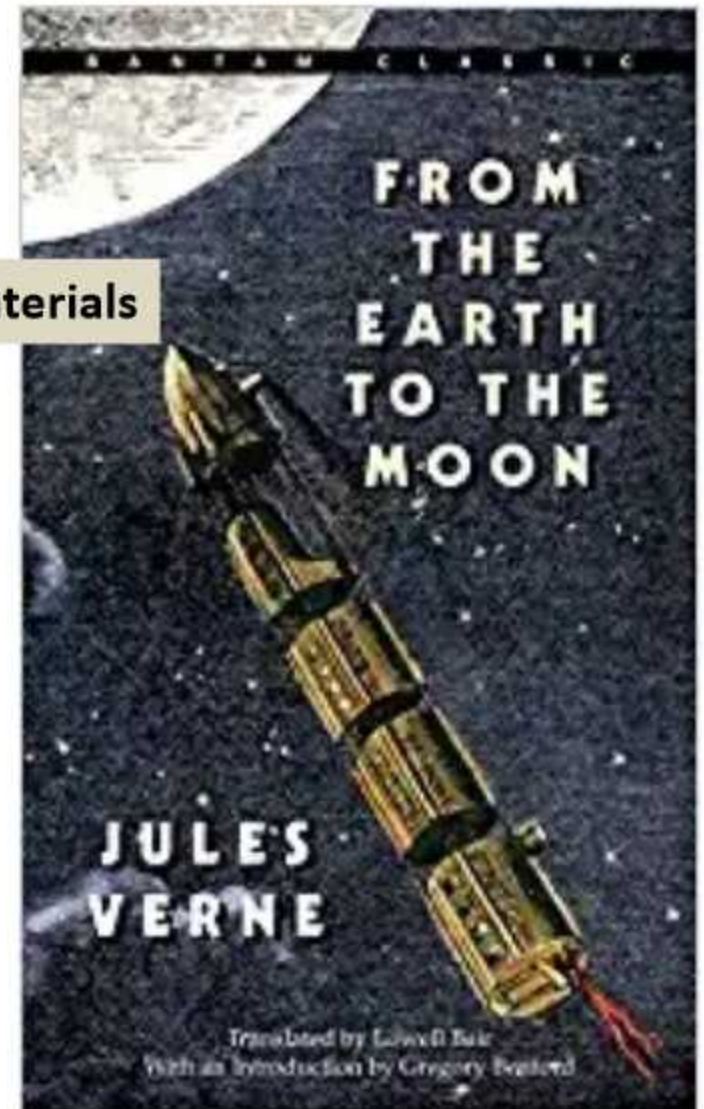
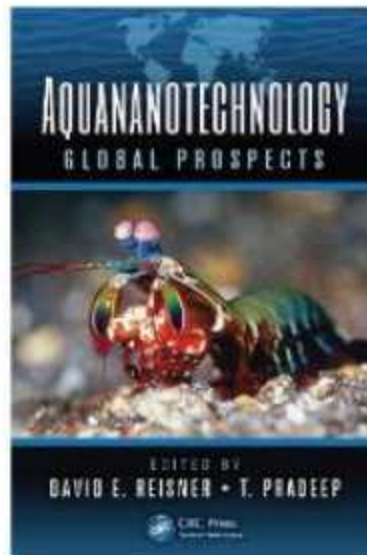
+45 °C, 99% RH

Our dreams become reality with materials

Affordable clean water is a matter of advanced materials

Emergence of nanotechnology

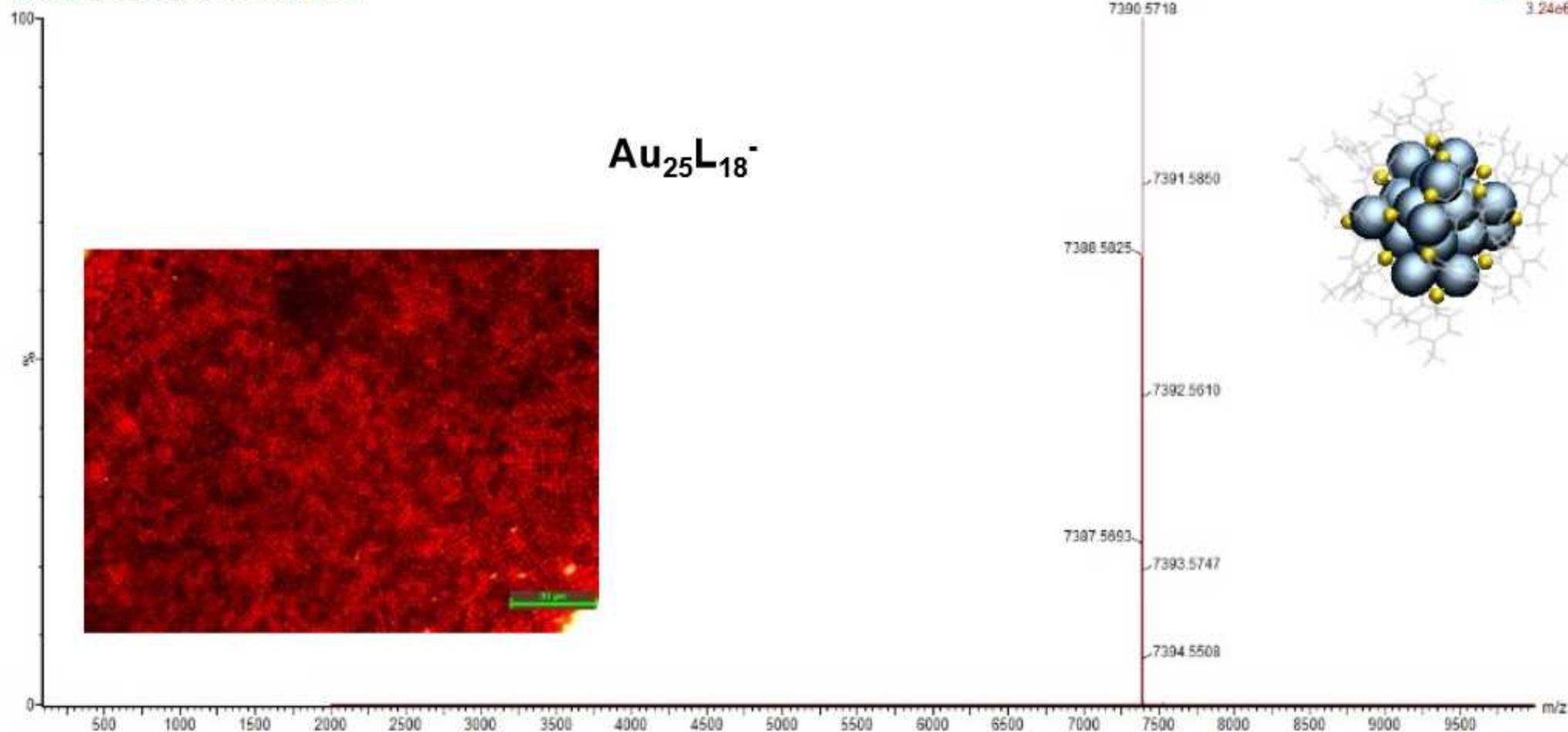
New adsorbents
New sensors
New catalysts
Novel phenomena
New devices



Nanomaterials are now atomically precise

With advanced methods of analysis, we study them in detail

AU26PET18_RES_NEG_MS_3_32 (0.658) Cm (5.80)



T. Pradeep et. al. *Acc. Chem. Res.* 2018; 2019.

Nanomaterials can solve real problems

A (Affordable)
S (Scalable)
S (Sustainable)
U (Universal)
R (Rapid)
E (Excellent)
D (Distinctive)

R. A. Mashelkar



Supplying
arsenic free
water to 1.2
million people,
every day

Supplying 60
million litres of
clean water
every day

Biopolymer-reinforced synthetic granular nanocomposites for affordable point-of-use water purification

Mohan Udhaya Sankar¹, Sahaja Aigal¹, Shihabudheen M. Maliyekkal¹, Amrita Chaudhary, Anshup, Avula Anil Kumar, Kamalesh Chaudhari, and Thalappil Pradeep²

Unit of Nanoscience and Thematic Unit of Excellence, Department of Chemistry, Indian Institute of Technology Madras, Chennai 600 036, India

Edited by Eric Hoek, University of California, Los Angeles, CA and accepted by the Editorial Board April 4, 2013 (received for review November 21, 2012)

Creation of affordable materials for constant release of silver ions in water is one of the most promising ways to provide microbially safe drinking water for all. Combining the capacity of diverse nanocomposites to other contaminants, these materials can be synthesized out of the use of sand-like porous forms. These nanocomposites can be used as a water purifier. The ability to purify water at ambient temperature is a significant advantage for water purification in rural areas.

hybrid | green |

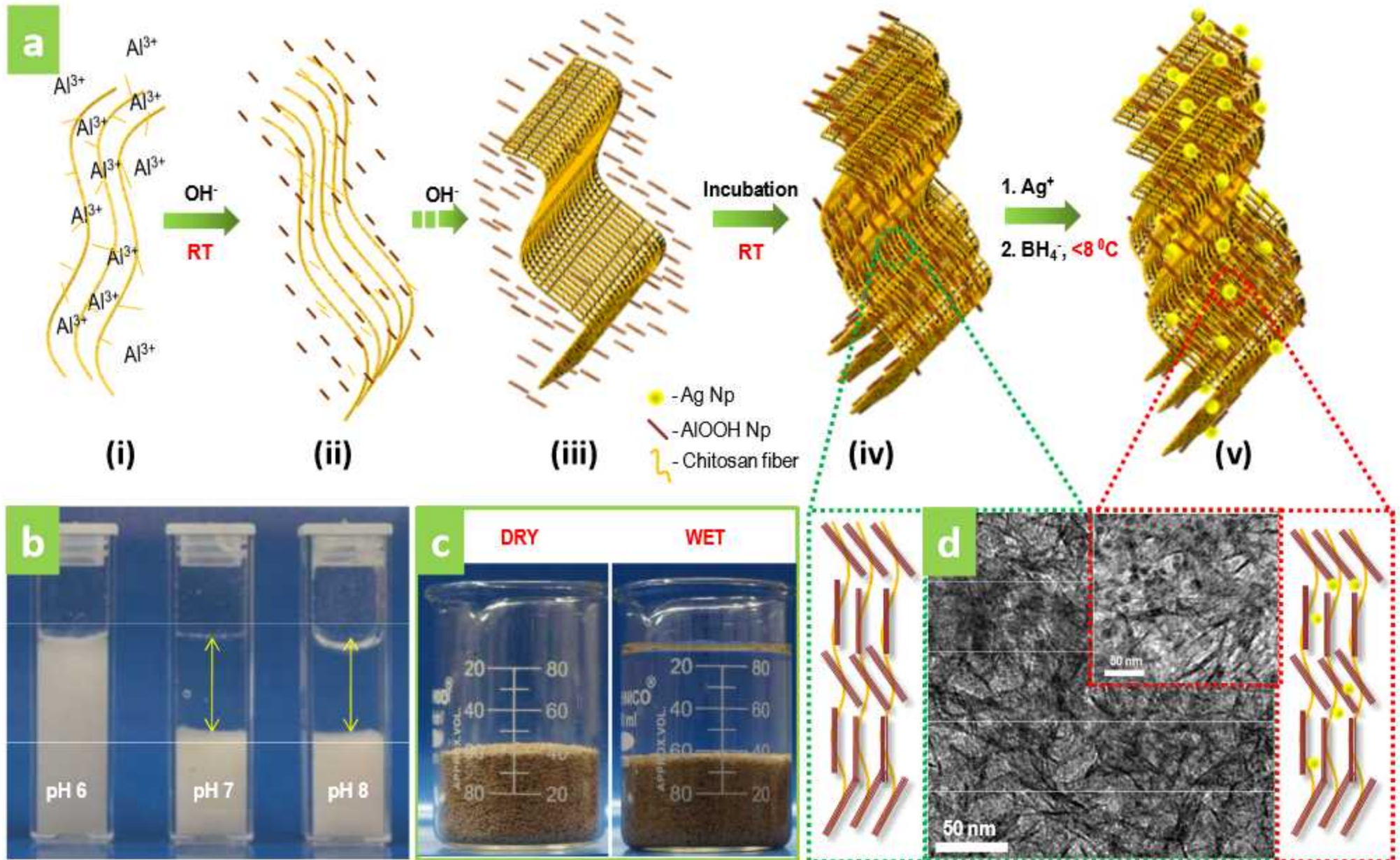


release into water are not available; and (c) continued retention of the nanoparticles in the matrix is difficult.

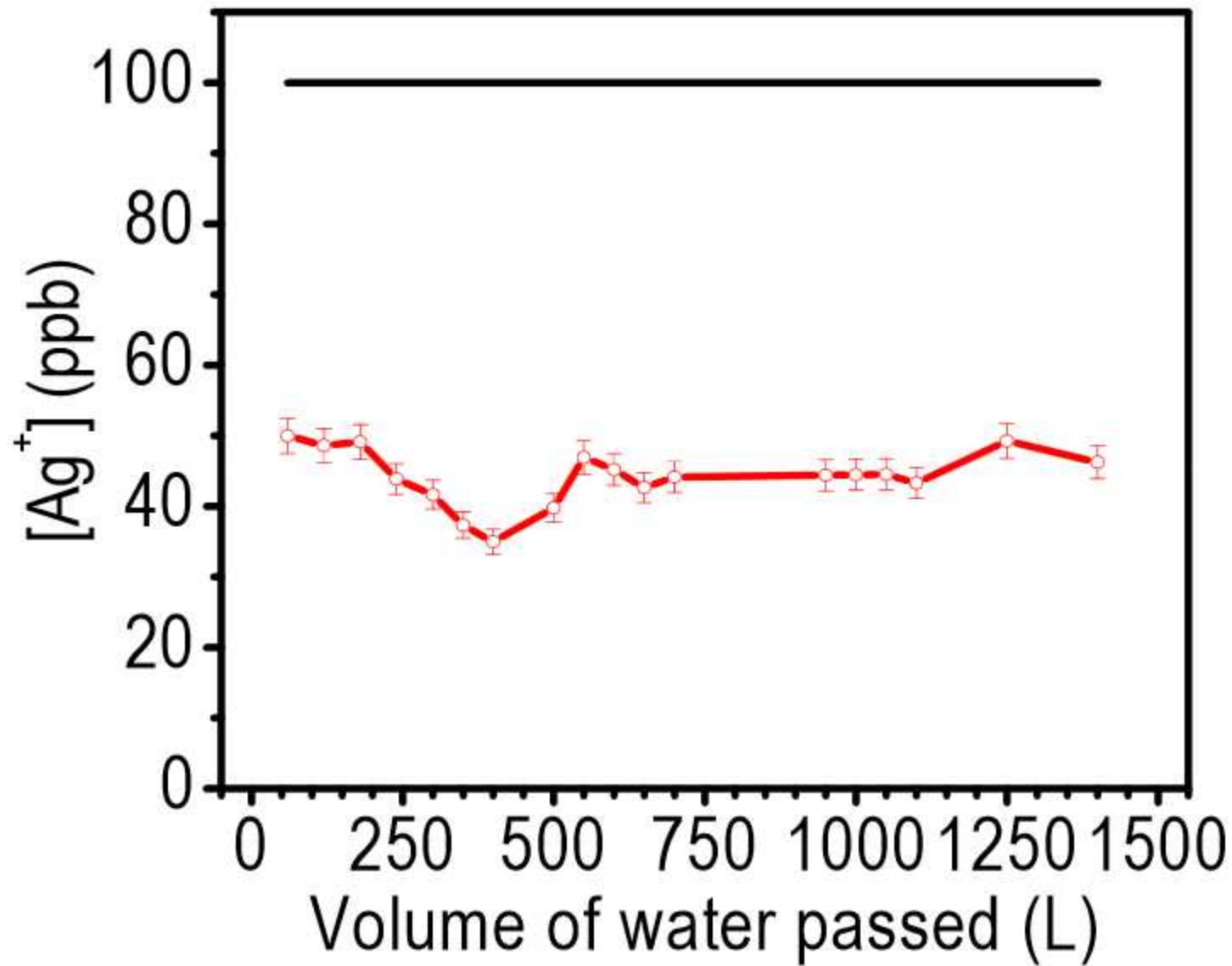
In this work, we demonstrate a unique family of nanocrystalline metal oxyhydroxide-chitosan granular composite materials prepared at near room temperature through an aqueous route. The degree of crystallinity in the composition is attributed to abundant $-OH$ functional groups on chitosan, which help in the crystallization of metal oxyhydroxide and also ensure strong covalent binding of the nanoparticle surface to the matrix. X-ray photoelectron spectroscopy (XPS) confirms that the composition is rich in surface hydroxyl groups. Using hyperspectral imaging, the presence of nanoparticle leaching in the water was confirmed. Further, a unique scheme to reactivate the silver nanoparticle surface is used for continual antimicrobial activity in drinking waters. Several other composites have been developed that can remove other contaminants in water. We demonstrate an affordable water purification device based on such composites developed over several years and undergoing field trials in India, as a potential solution for widespread eradication of the waterborne disease burden.

Results and Discussion

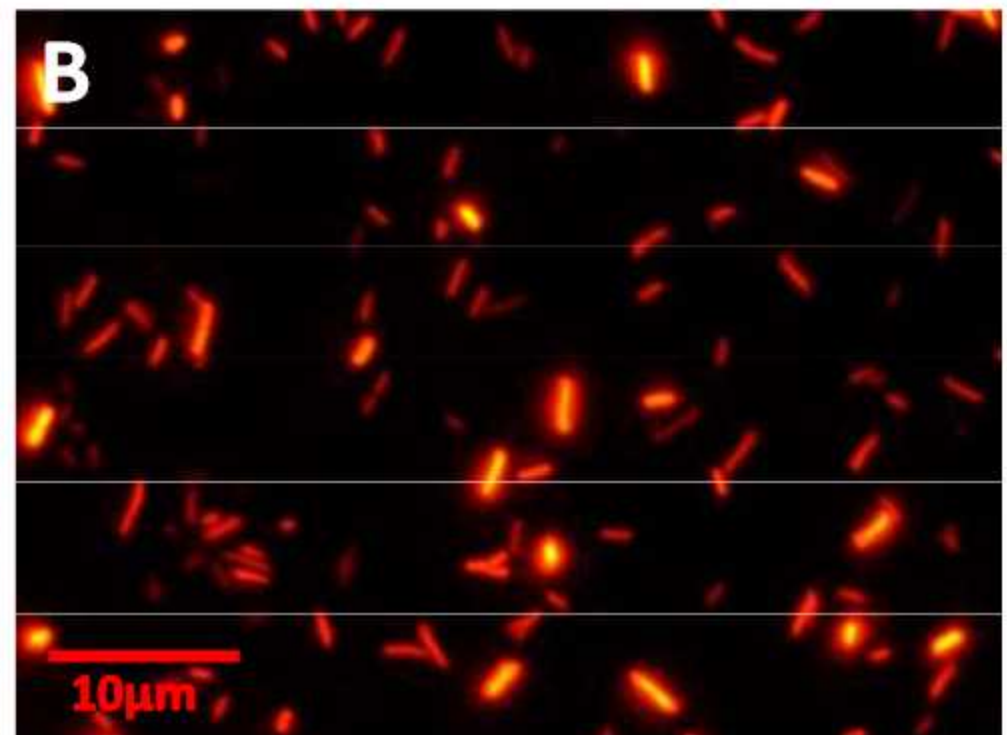
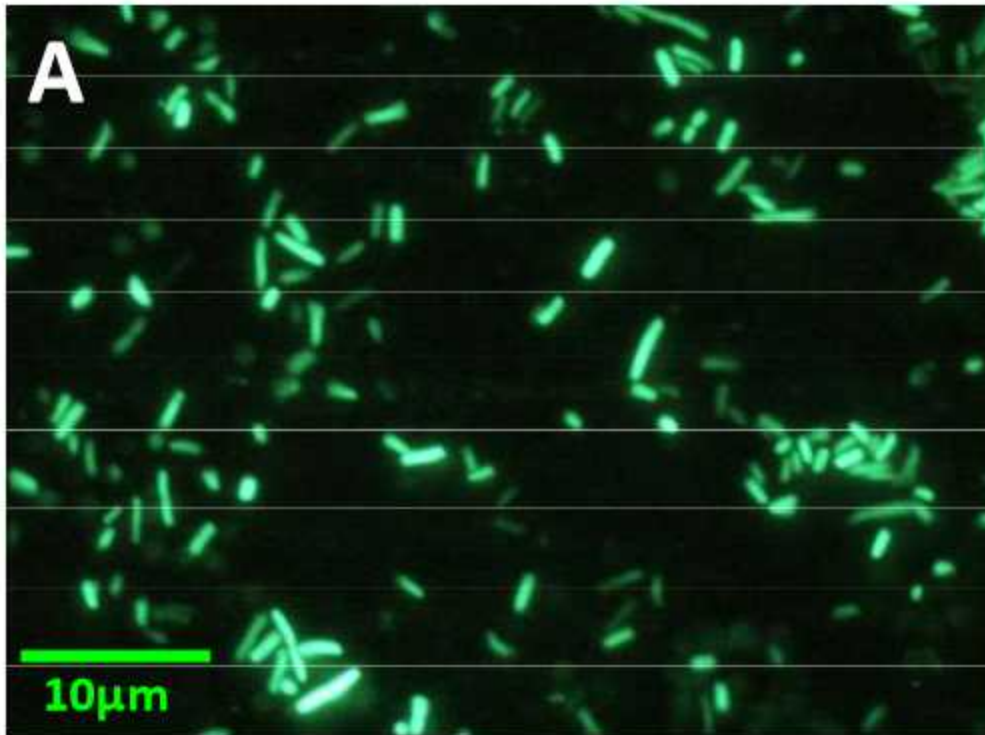
New materials

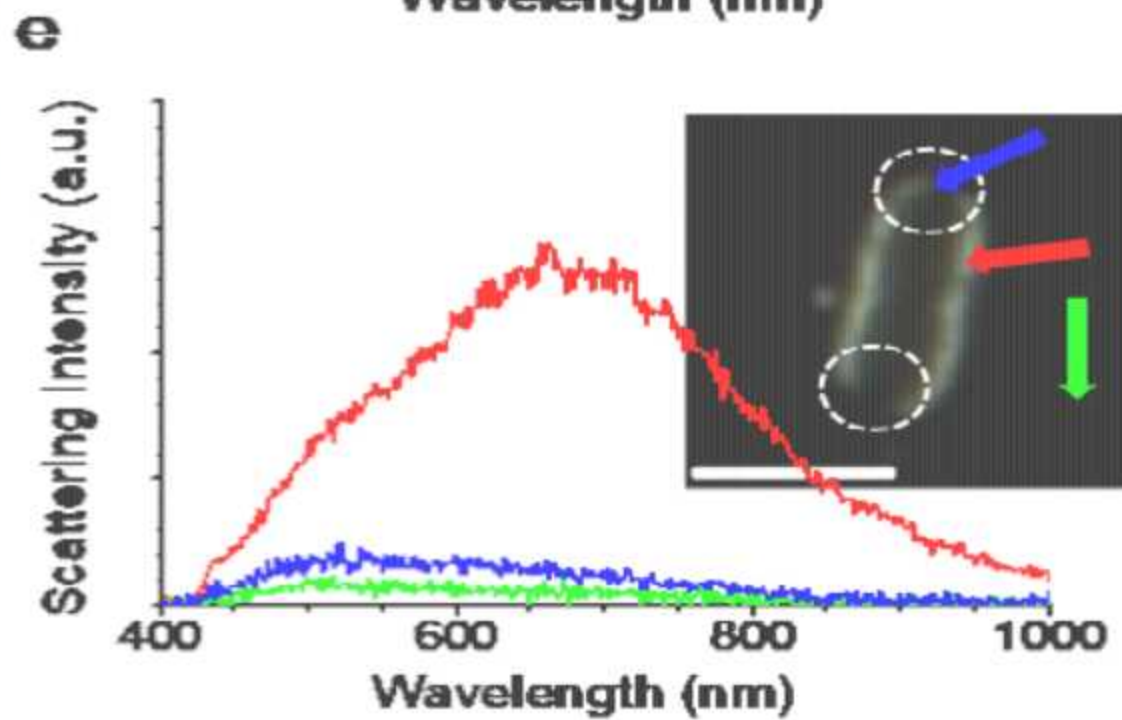
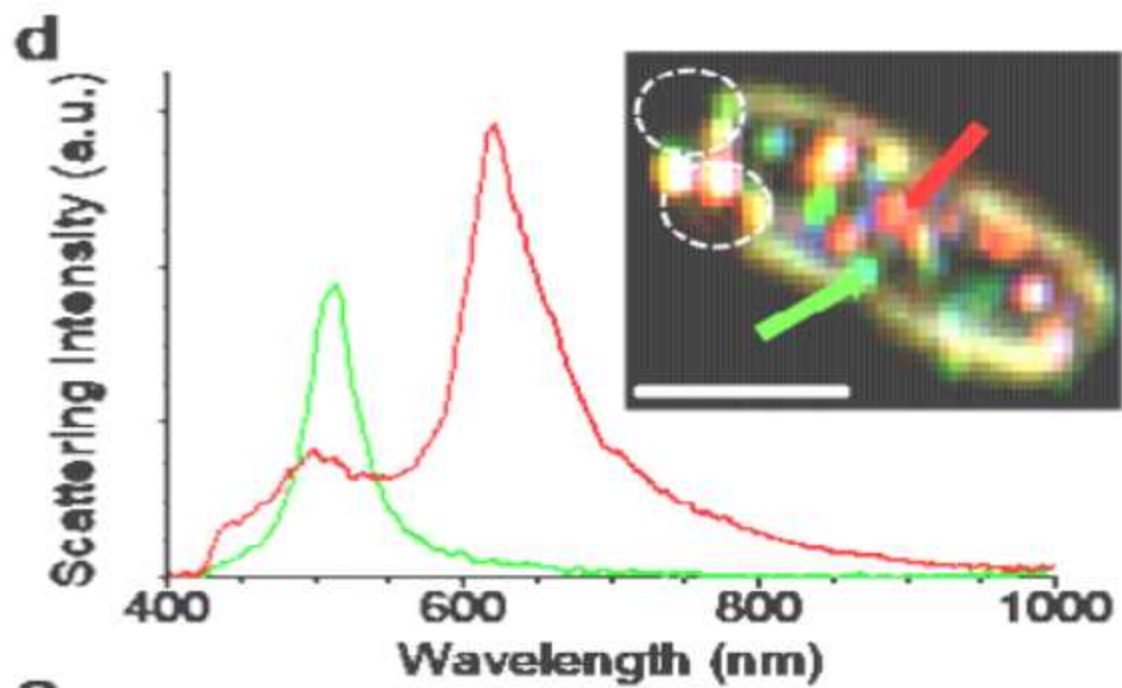
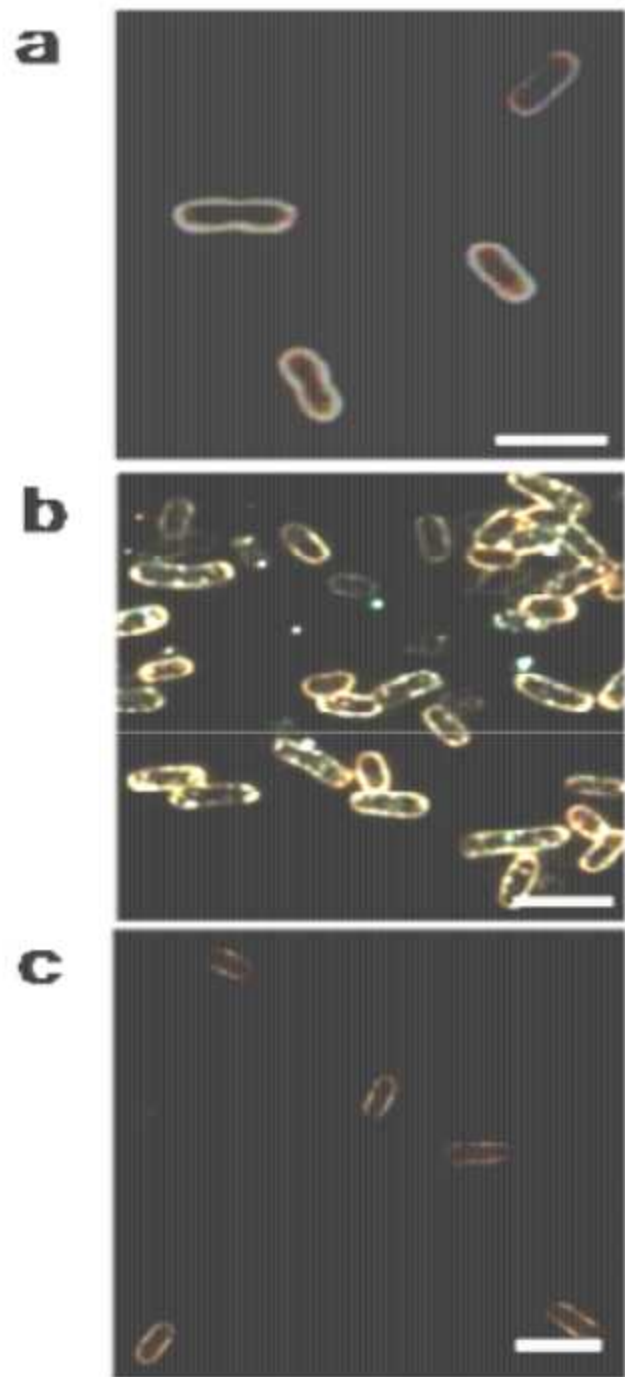


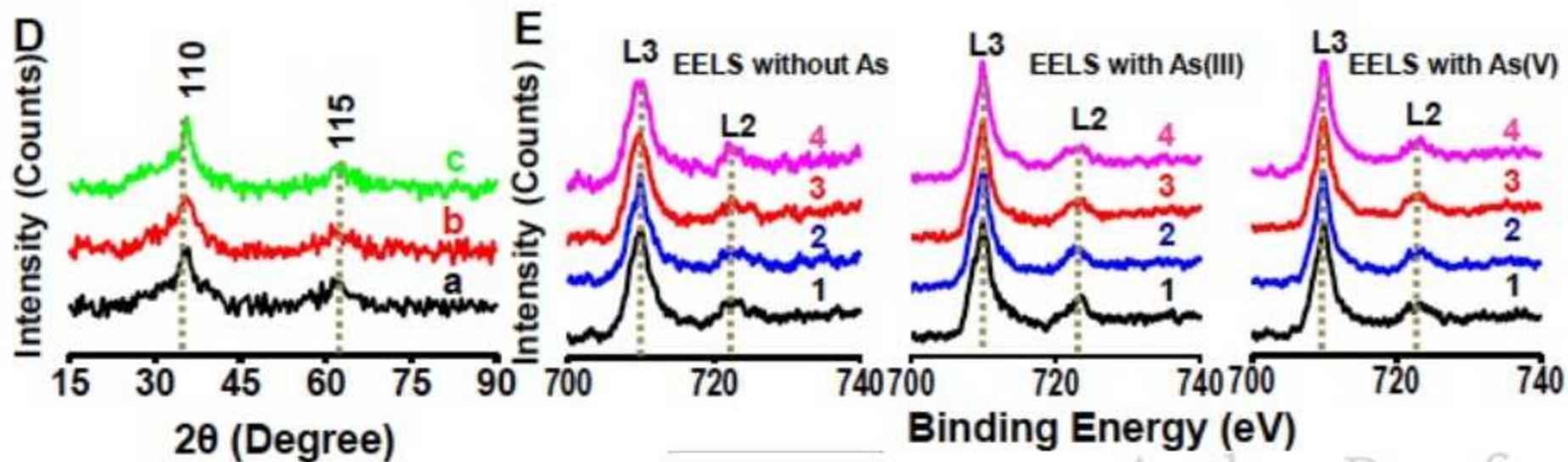
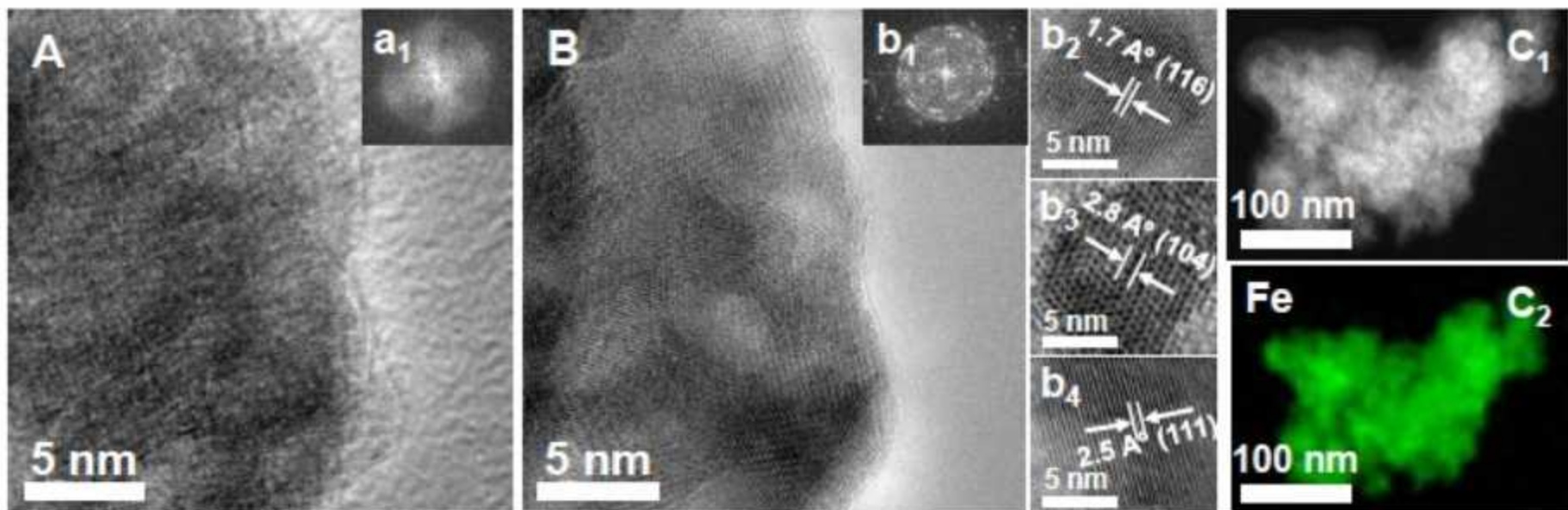
What is special?



Live/dead staining experiments





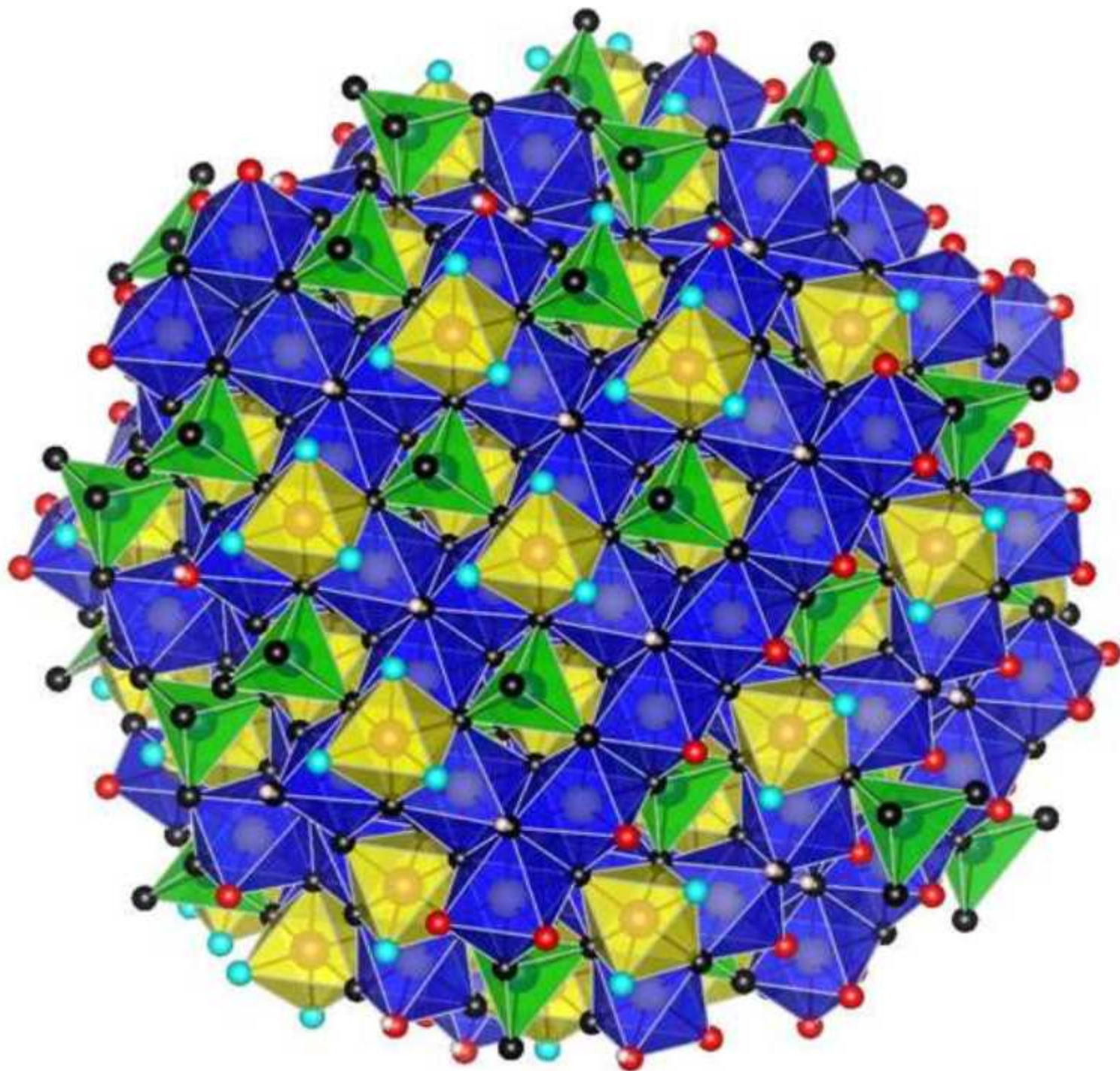


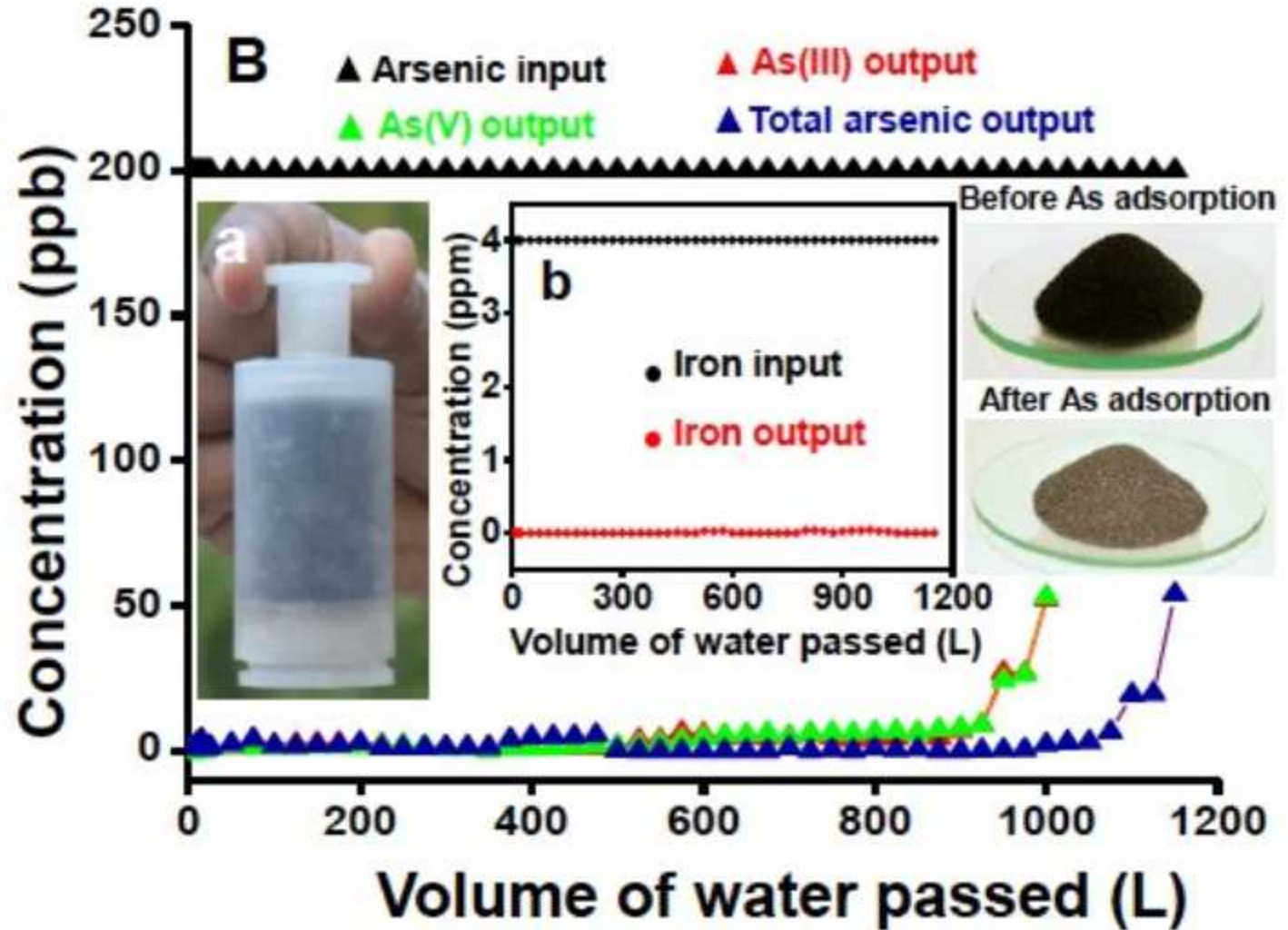
www.advmat.de

Author Pr ⁶ ADVANCED MATERIALS

Confined Metastable 2-Line Ferrihydrite for Affordable Point-of-Use Arsenic Free Drinking Water

By Avula Anil Kumar, Anirban Som, Paolo Longo, Chennu Sudhakar, Radha Gobinda Bhuin, Soujit Sen Gupta, Anshup, Mohan Udhaya Sankar, Amrita Chaudhary, Ramesh Kumar, and T. Pradeep*





Changing the dynamics in the field



- Existing unit for iron and arsenic removal – 20 m³/h
- Uses activated alumina and iron oxide (old generation of adsorbents)

- Existing unit for iron and arsenic removal – 18 m³/h
- Uses iron oxyhydroxide (new generation of adsorbents)
- Input arsenic concentration: 168 ppb
- Output arsenic concentration: 2 ppb

Completed 3 years maintenance (stipulated: 2 years)
for 330 bamboo unit project in Nadia, WB



Minimum uptime: 91%, Maximum: 98%
Only 4/330 have reported arsenic above 10 ppb
Benefiting over 100,000 children and villagers

Glimpse of Installed units (330 nos)

Seeing how the new adsorbents are changing the dynamics at the ground level (type 1 of our efforts)



Name of the scheme: Mahilan Wala (TW9144), District: Amritsar
Population: 2610, Daily demand@70 LPCD: 188 kLD, OHSR Capacity:
100 kL

Community units – 25 KL – 1000 KL



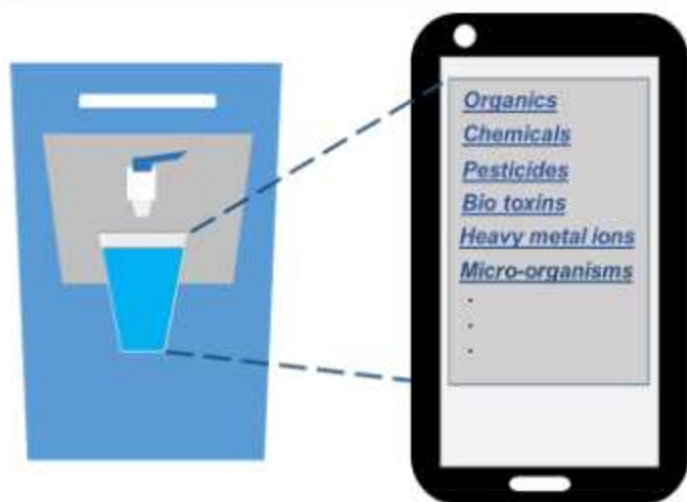
Cleanwater at 2.1 paise per litre!

Calculation for the Tariff to be collected for treated water (Revision if Required)

Sr.No	Design population	1,071	Plant capacity/70 LPCD
	Item/Description	Cost / Quantity	Remarks
1	Cost of Replacement of Iron removal media	56400	After minimum two years if Iron concentration is more than 5 ppm. But iron concentration is more than 5 ppm at only two to three places. Therefore media may work for 3 years also.
2	Cost of Replacement of Arsenic removal media	978660	After minimum two years if Arsenic concentration is more than 100 ppb. But arsenic concentration is more than 100 ppb at only two to three places. Therefore media may work for 3 years also.
3	Cost of replacement of Activated Carbon	28560	
4	Total cost of Replacement of media	1063620	After minimum two years.
5	Total cost of Replacement of media for one year	531810	
6	Plant capacity	75000	ltr per day
7	Design population	1,071	Plant capacity/70 LPCD
8	Cost per liter of water	2.1 Paise per ltr	
9	Cost of replacement of media	1.36	Rs. per head per day
		40.80	=Media replacement cost per year/365/Design population per head per month for 70 LPCD water

Smart water purifiers and big data

Smart Water Purifiers linked to IoT



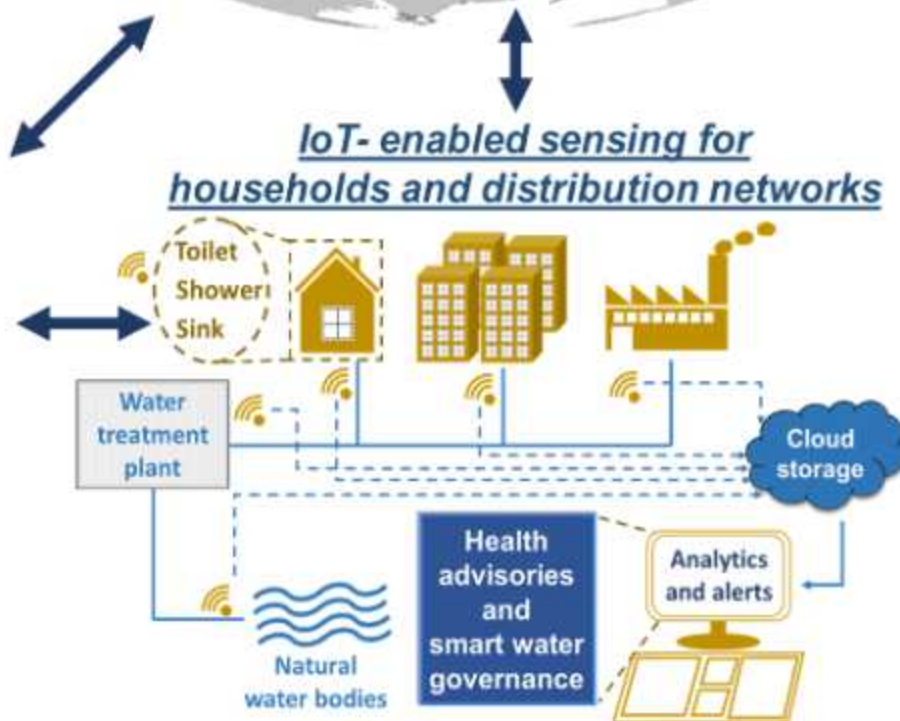
Global Map of Water Health



Cost-effective sensor accessory for point-of-use applications



IoT-enabled sensing for households and distribution networks





Automation of water supply scheme



AMRIT – Household Water Purifier



AMRIT

Arsenic and Uranium Removal by Ion Exchange Technology



- AFORDABLE**
Water purifier for Rs. 2000/-
- EASY INSTALLATION**
With no plumbing
- EASY MAINTAINABILITY**
Standard 12 liter water tank
- ADAPTABLE**
Capacity 20-24 liter

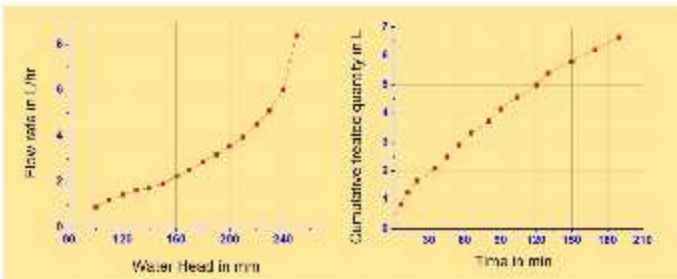
ITEMS IN THE BOX



INSTALLATION PROCEDURE



CLEANING OF TAPFAUL



Technical Details

Parameter	Unit	Output water quality
Capacity	20-24 LTR	1 LTR (ARSENIC, URANIUM, IRON, TURBIDITY)
Flow rate	2-7 LTR	20-24 LTR (20-24 liter)
ARSENIC	10-2000 µg/L	10-2000 µg/L
URANIUM	10-2000 µg/L	10-2000 µg/L
IRON	10-2000 µg/L	10-2000 µg/L
TURBIDITY	10-2000 NTU	10-2000 NTU

Product Name: AMRIT – Household Water Purifier by Ion Exchange Technology

Product description: An efficient, compact, easy-to-use, and affordable water purifier. It is designed to remove arsenic, uranium, iron, and turbidity from tap water. The purifier is made of high-quality materials and is easy to install and maintain.

Product features: The purifier is made of high-quality materials and is easy to install and maintain. It is designed to remove arsenic, uranium, iron, and turbidity from tap water. The purifier is made of high-quality materials and is easy to install and maintain.

Installation: The purifier is easy to install and maintain. It is designed to remove arsenic, uranium, iron, and turbidity from tap water. The purifier is made of high-quality materials and is easy to install and maintain.

Capacity: The purifier has a capacity of 20-24 liters. It is designed to remove arsenic, uranium, iron, and turbidity from tap water. The purifier is made of high-quality materials and is easy to install and maintain.

Flow rate: The purifier has a flow rate of 2-7 liters per hour. It is designed to remove arsenic, uranium, iron, and turbidity from tap water. The purifier is made of high-quality materials and is easy to install and maintain.

ARSENIC: The purifier can remove arsenic from tap water. It is designed to remove arsenic, uranium, iron, and turbidity from tap water. The purifier is made of high-quality materials and is easy to install and maintain.

URANIUM: The purifier can remove uranium from tap water. It is designed to remove arsenic, uranium, iron, and turbidity from tap water. The purifier is made of high-quality materials and is easy to install and maintain.

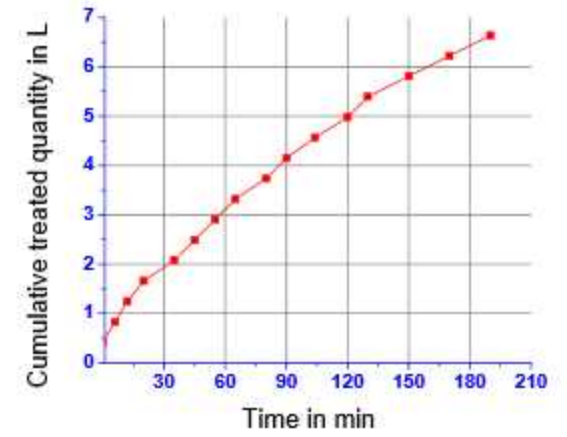
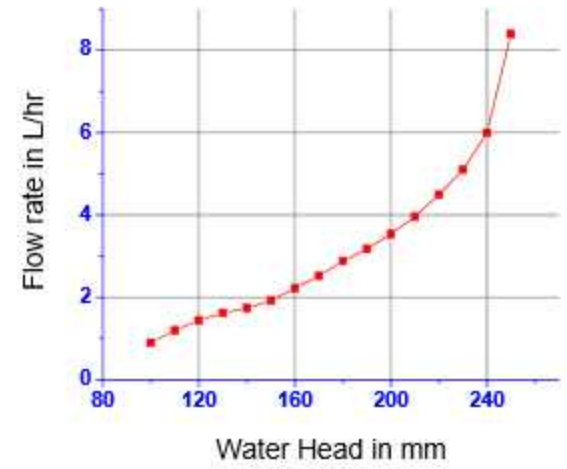
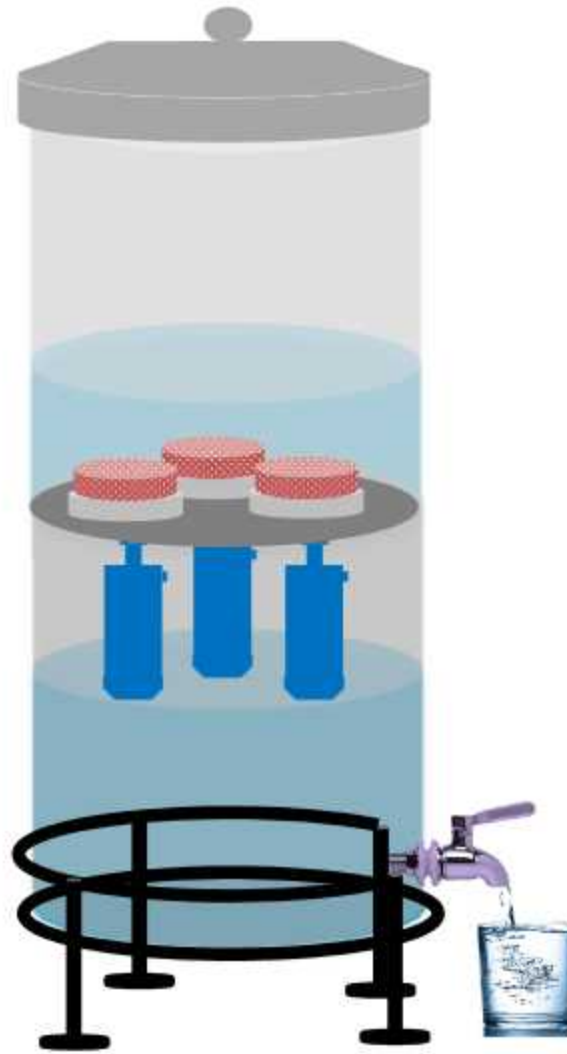
IRON: The purifier can remove iron from tap water. It is designed to remove arsenic, uranium, iron, and turbidity from tap water. The purifier is made of high-quality materials and is easy to install and maintain.

TURBIDITY: The purifier can remove turbidity from tap water. It is designed to remove arsenic, uranium, iron, and turbidity from tap water. The purifier is made of high-quality materials and is easy to install and maintain.

Price: The purifier is available for Rs. 2000/-.

Contact: For more information, please contact us at 020-26111111.

About 12,800 household water purifiers are provided to Arsenic and Uranium affected villages where retrofitted treatment plants are not installed. This water purifier removes turbidity, Iron and Arsenic/Uranium.





12 : 43 : 13

04-01-2021 Thursday

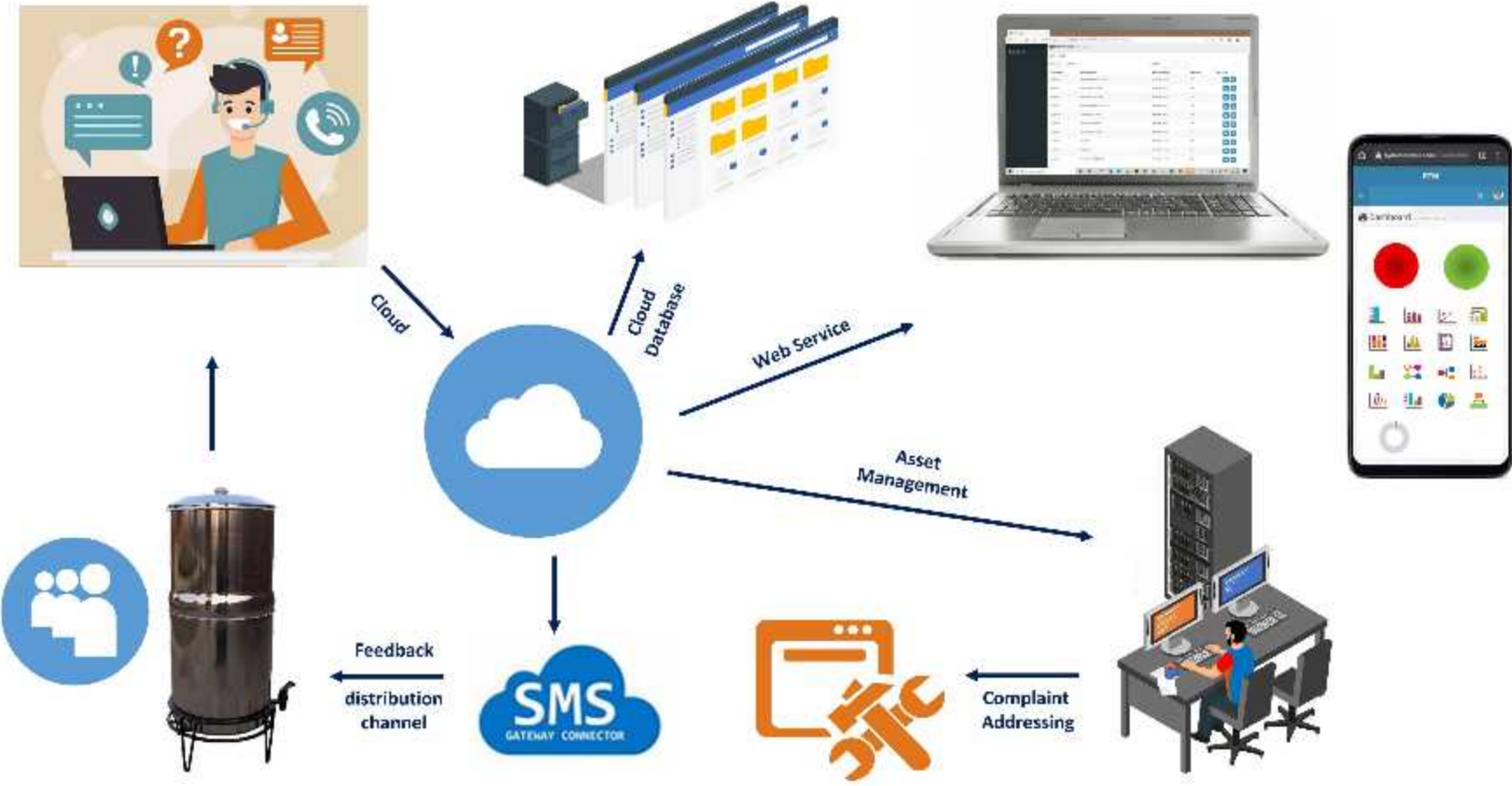
Mari Nauabad

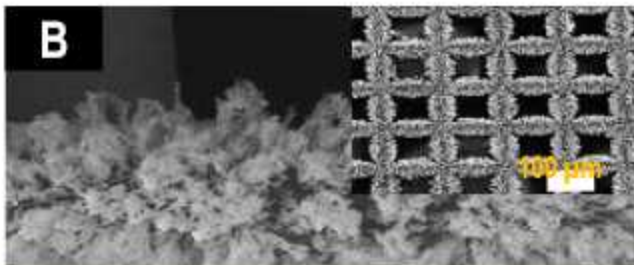
There is no reason for anyone to suffer from water quality – As, U, F, Hg,....



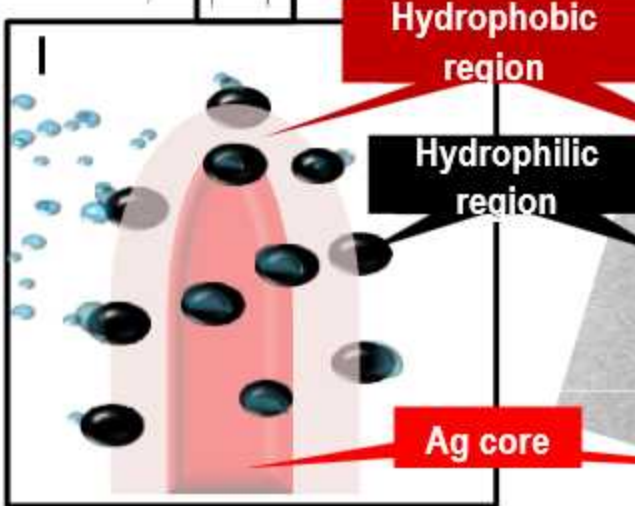
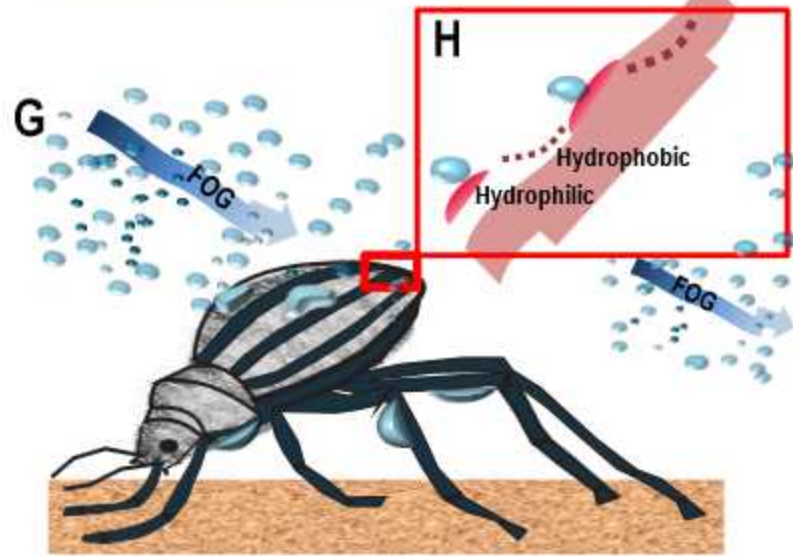
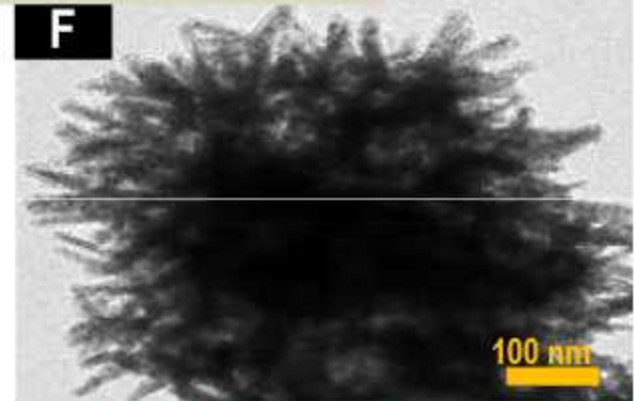
Glimpses of household water purifier

Snapshot view of household water purifier customer care web platform

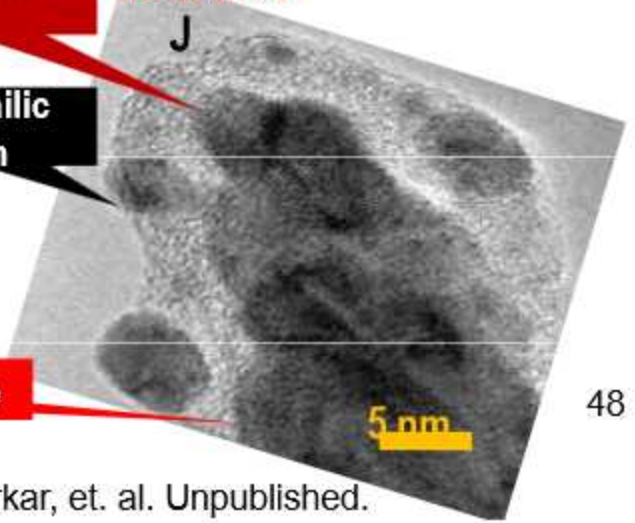


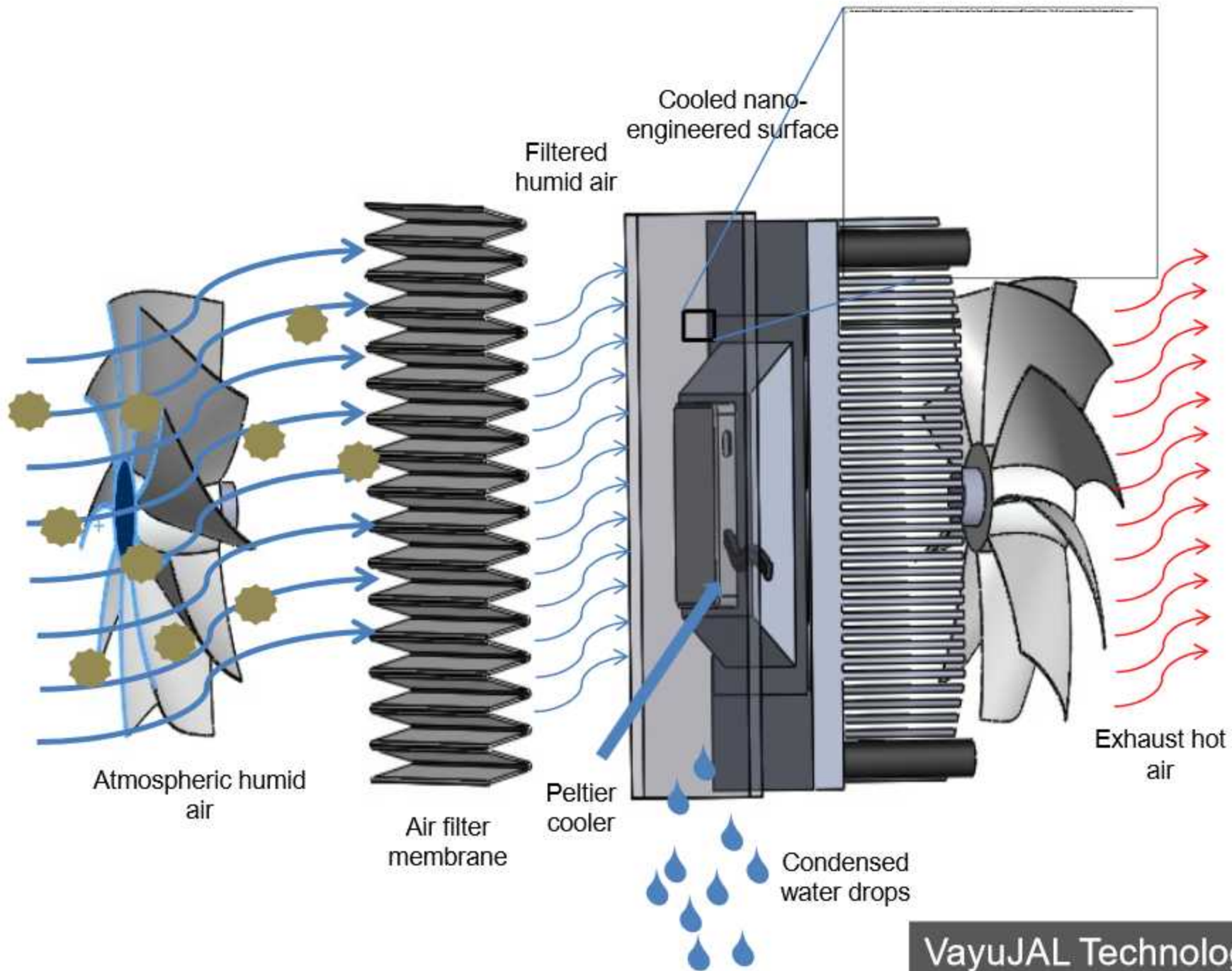


What do we do when water is not there?
Harvest humidity!



Combination of cactus and Namib desert beetle effect





VayuJAL Technologies Pvt. Ltd.
Ramesh Kumar Soni and Ankit Nagar

Products in the field



35 LPD 120 LPD
LPD

400 LPD

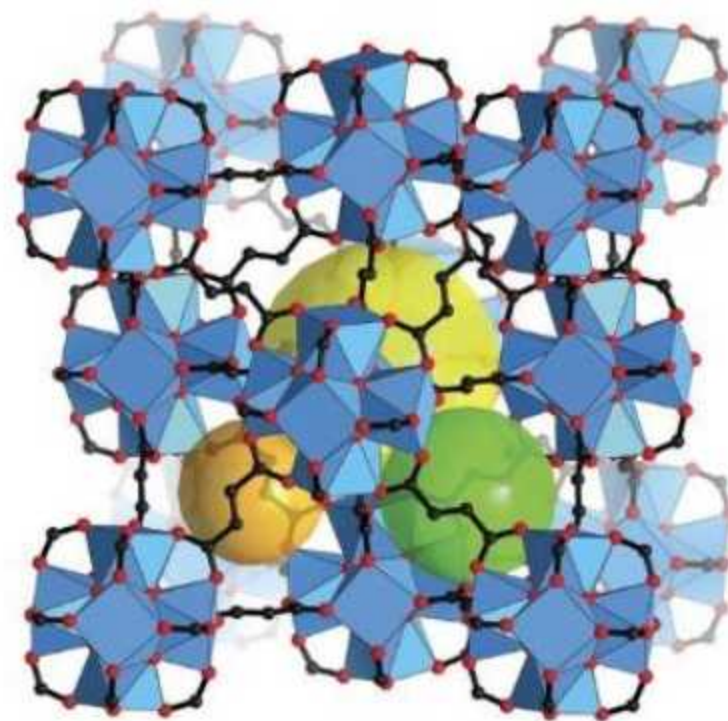
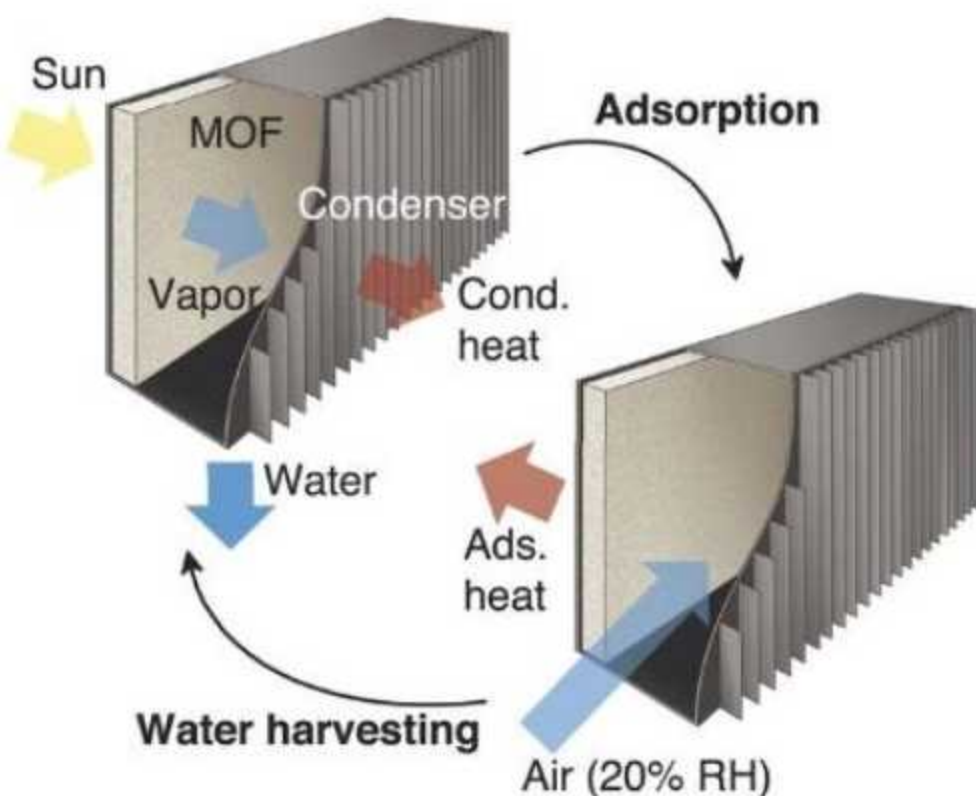
1000 LPD

2000

(LPD: Litres per day)

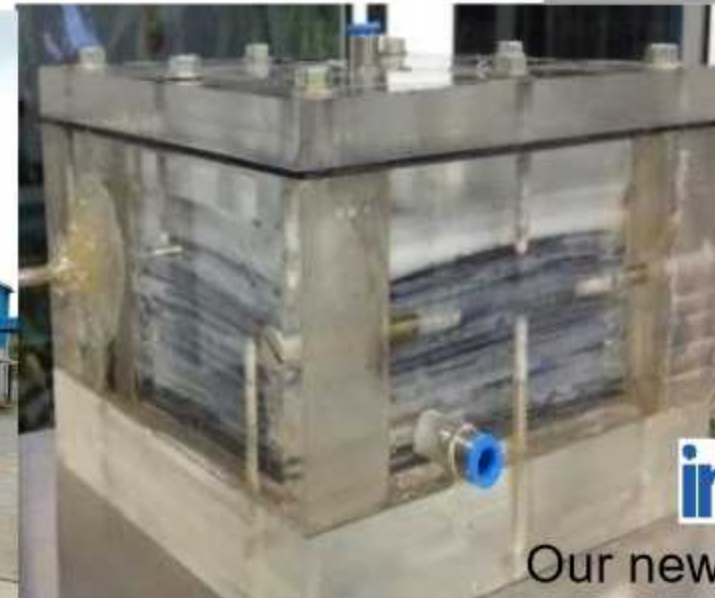
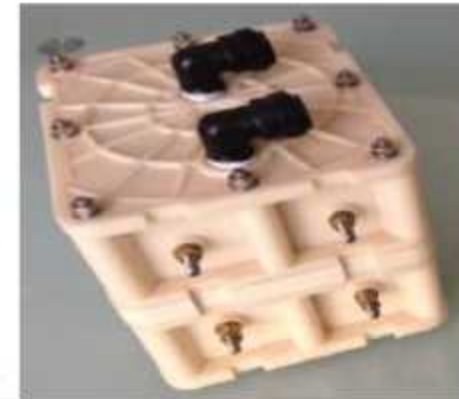
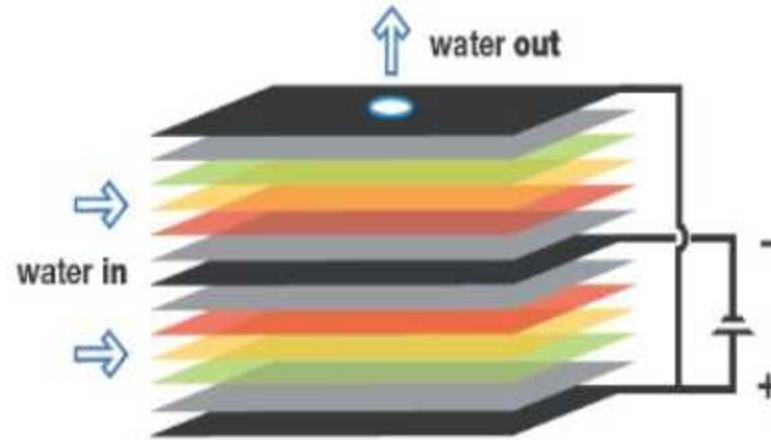
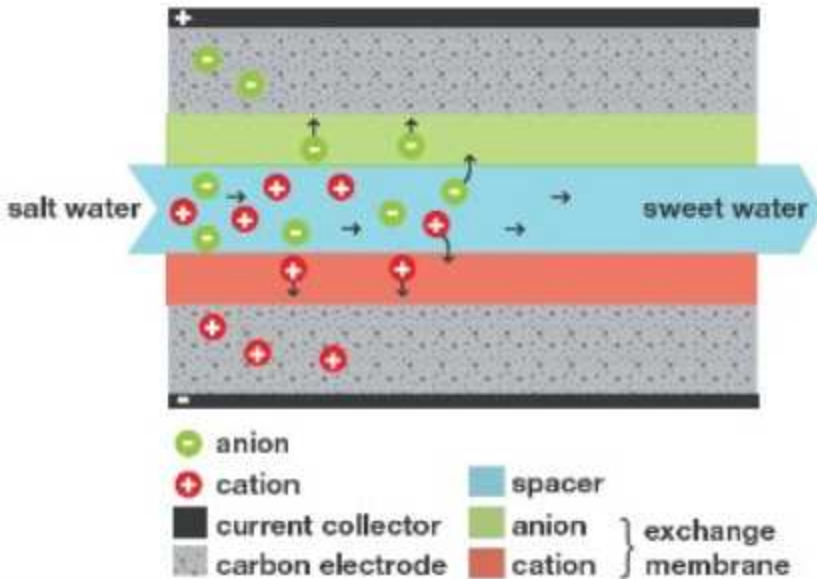
Sustainable atmospheric water harvesting

Solar- heat-enabled atmospheric water capture at a relative humidity as low as 20%



Porous metal-organic framework (MOF-801, $Zr_6O_4(OH)_4(\text{fumarate})_6$)

Capacitive Desalination (CDI) – brackish water



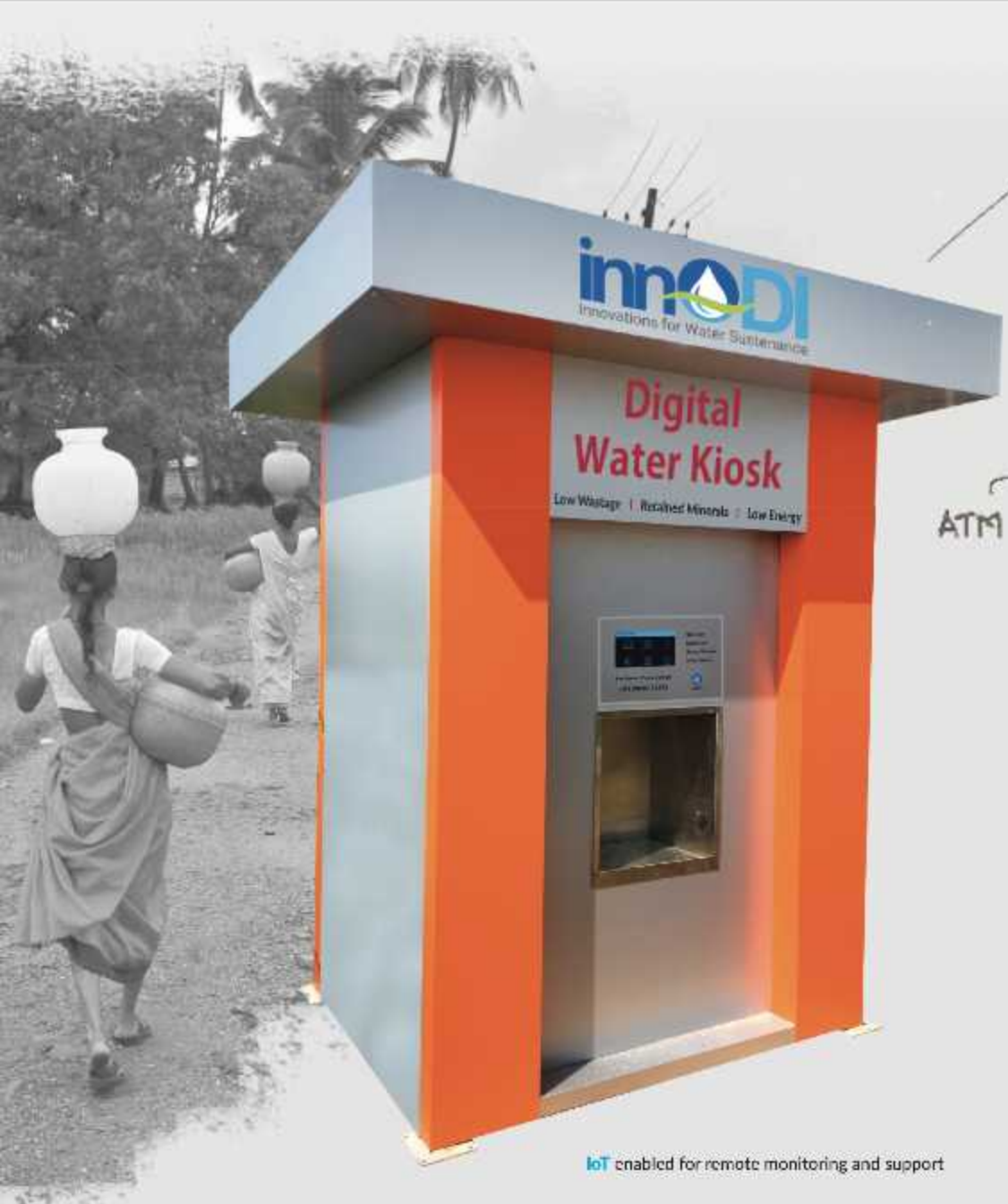
imODI

Our new company

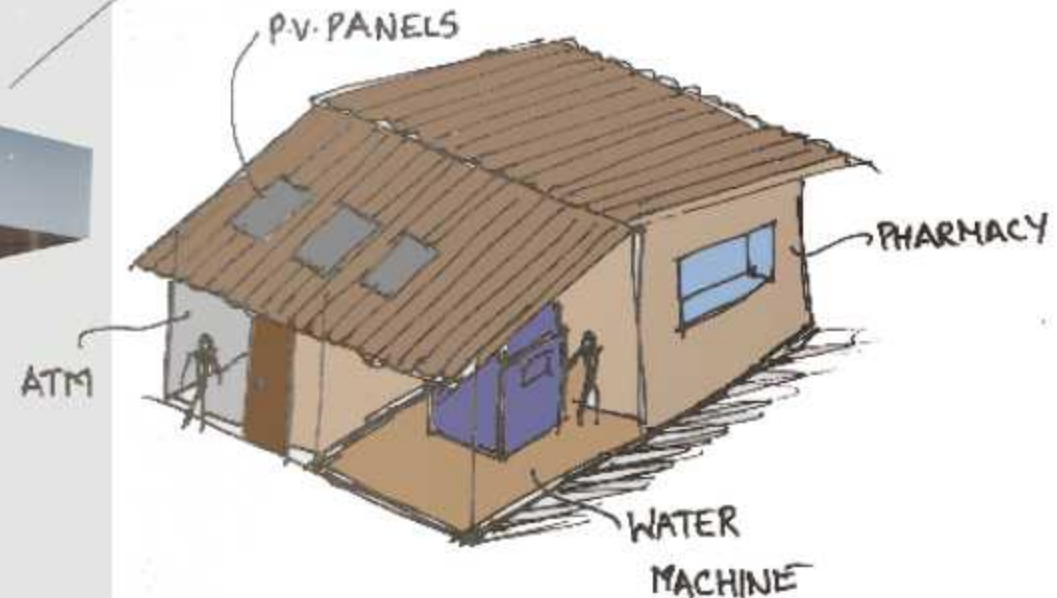
Soujit Sengupta, Rabiul Islam and others

DIGITAL WATER KIOSK

for community drinking using CDI Technology



IoT enabled for remote monitoring and support



Products under implementation

Vijay Sampath and Tullio Servida

Analytical devices

Universal
Wireless
Electrochemical
Detector

Smartphone

Internet

Disposible
Electrode

1	2											10	11	12	13	14	15	16	17	18																																																			
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Na	Mg																	Al	Si	P	S	Cl	Ar																																																
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K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																																																						
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Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																																																						
55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118								
Cs	Ba			Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																																																					
87	88			89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150						
Fr	Ra			Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og																																																					
		La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu																																																							
		Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr																																																							

Sensors and new opportunities



Analog/Grating
Equipment

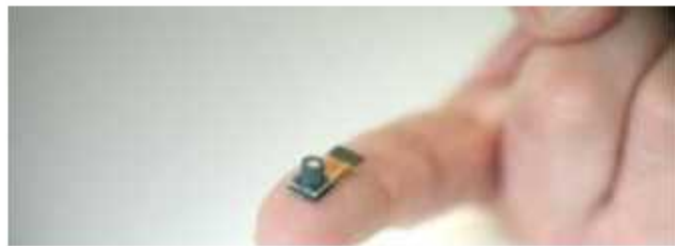
\$ 5~6 Billion (2017)

a few **100k units (2017)**



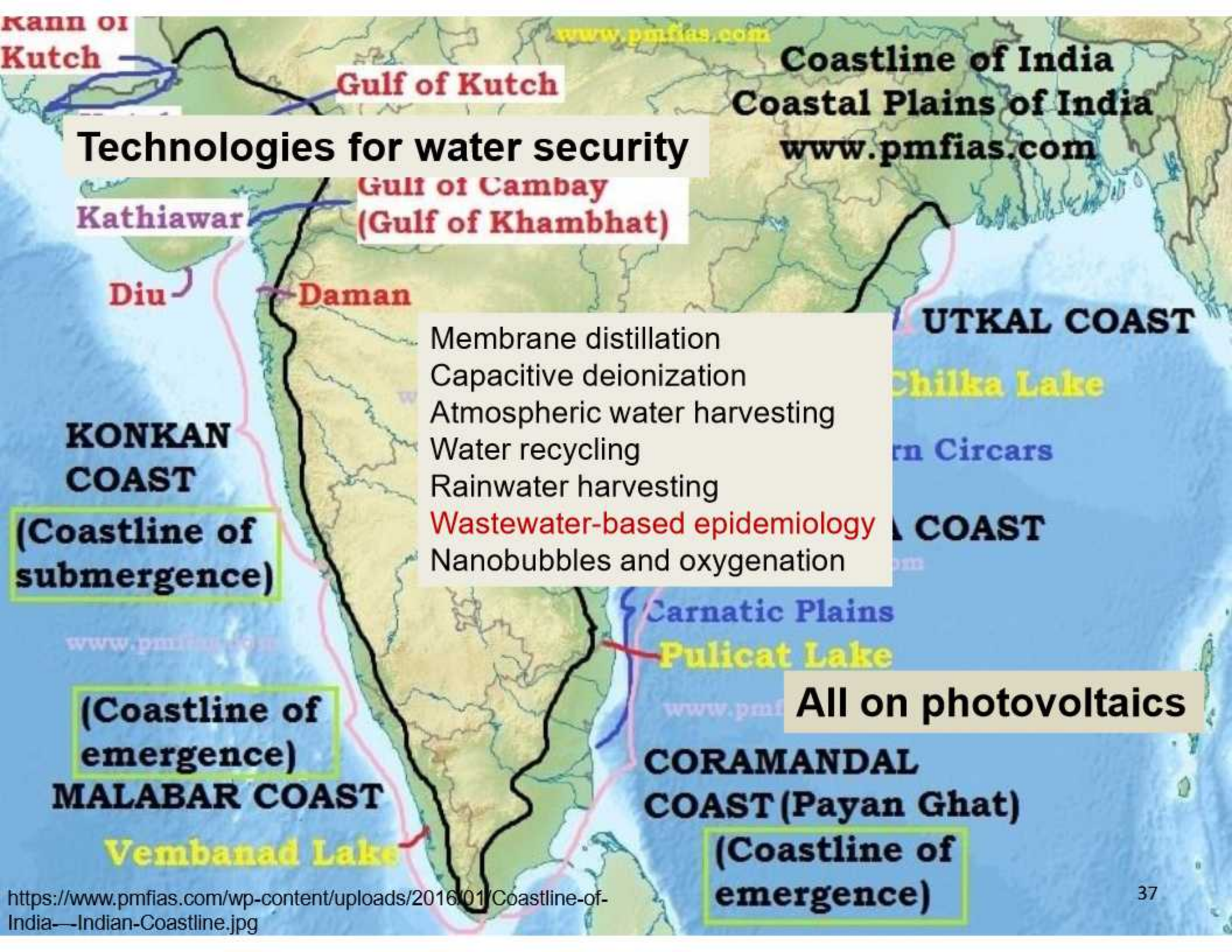
**Ultra compact Low Cost
Spectral Sensor Module**

~ Billions units (? 2027)



Water quality measurement – In the pipeline

nano λ



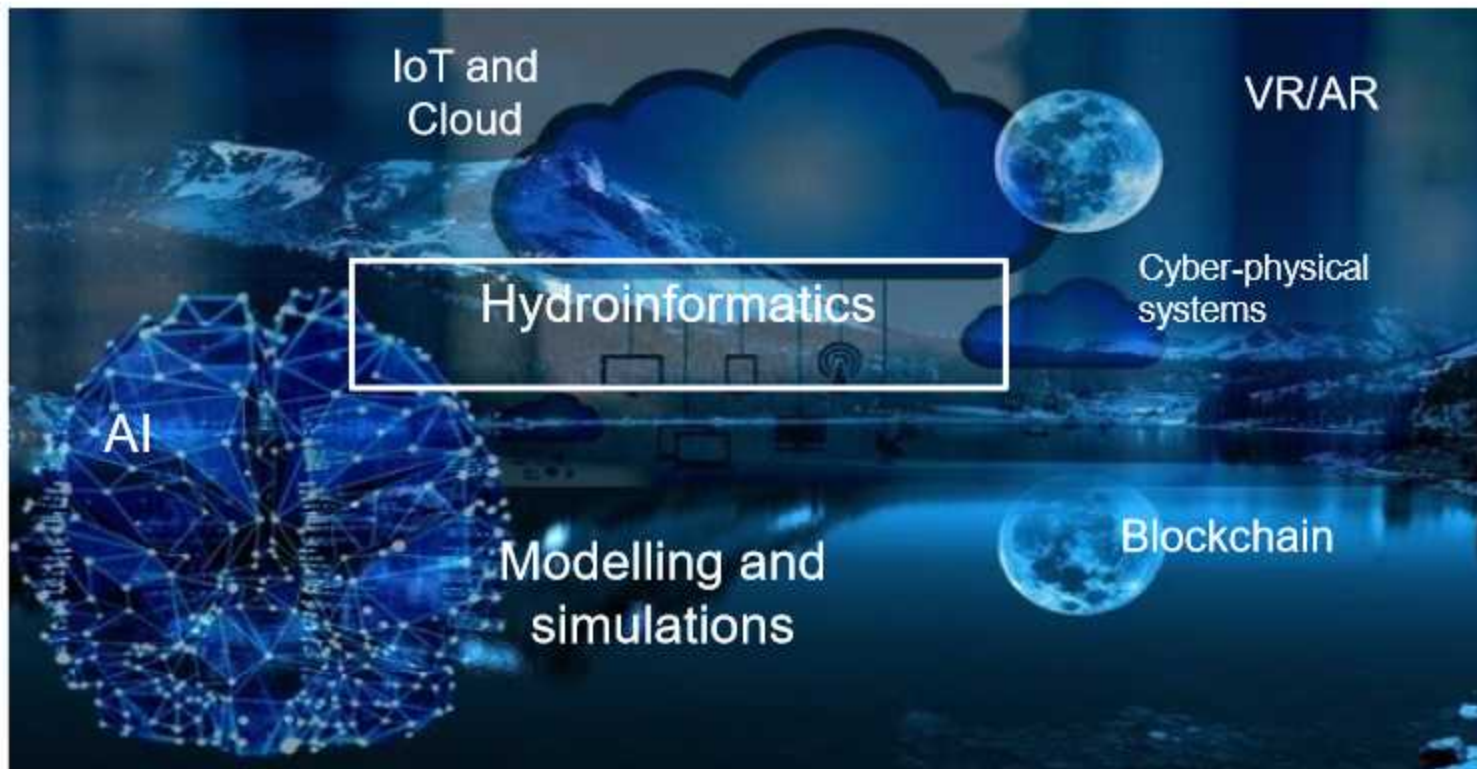
Technologies for water security

- Membrane distillation
- Capacitive deionization
- Atmospheric water harvesting
- Water recycling
- Rainwater harvesting
- Wastewater-based epidemiology
- Nanobubbles and oxygenation

All on photovoltaics

Hydroinformatics

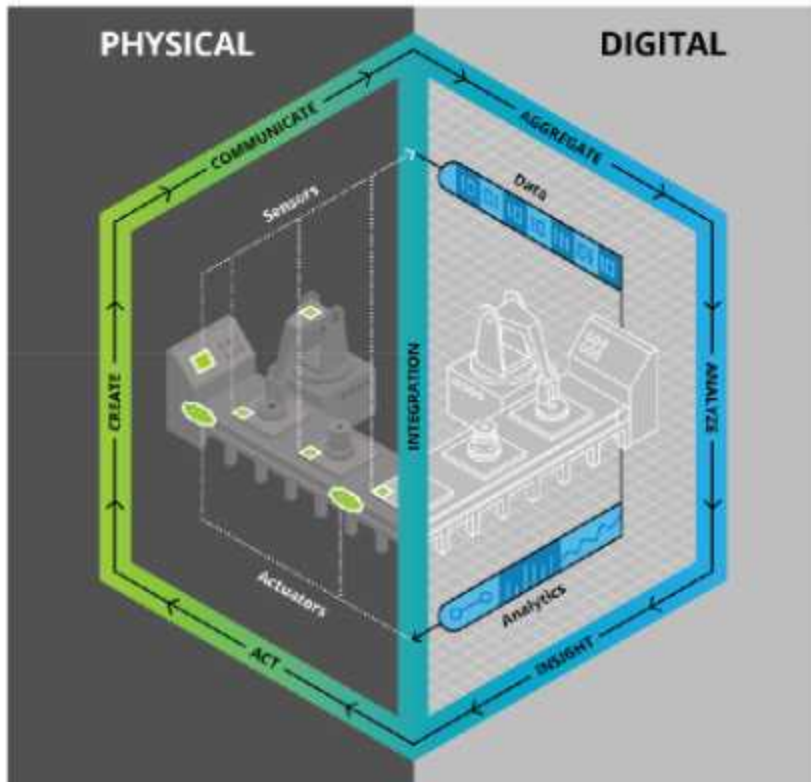
Application of computing technologies for efficient, sustainable and equitable water management.



Digital water or water 4.0 will revolutionize water management.

Water 4.0

Digital twin of water resources



Source: Deloitte University Press.

Deloitte University Press | dupress.deloitte.com

Digital twin is the digital visualization and representation of a physical or natural system, which may gather data continuously from its physical counterpart and interact with it via a control system.

Create a digital twin of different elements of hydrologic environment – surface water bodies, ground water, rivers, and urban water utilities.

Data-driven modelling of events such as flood inundation of rural and urban areas with 3D visualization using the digital twin representation of the landscape.

Integration of real-time modelling of groundwater and surface water, water supply networks and utilities combined with analytics platform more accurate decision making.

Genetic diversity – opportunities and sustainability

Traditional knowledge



<https://www.unnatisilks.com/blog/naturally-colored-cottons-a-regain-in-popularity/>

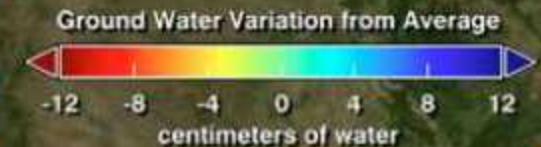
Indian agriculture

67% of agriculture run on GW

Total districts 742
Water stressed >300
256 with critical or overexploited ground water levels
'India is suffering from its worst water crisis in its history.'

November 2002

November 2008



Data from NASA

Arsenic free rice



Iron rich, silver rich, etc. rice

So much is happening on the ground



Policy



International Centre for Clean Water



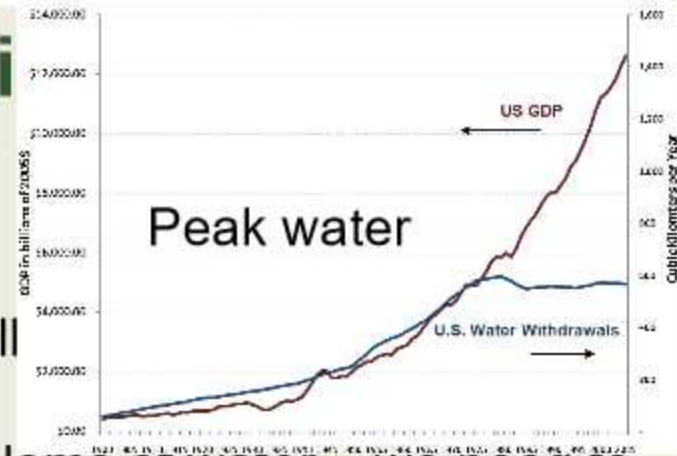
IIT Madras Research Park

Water is big and India i

Per capita water availability – 1500 CM

That water and its benefits need to reach all

We have solutions for each one of the problems of water – we need to invest in them - water has to be brought to the living room



Peter H. Gleick and Meena Palaniappan, PNAS, 2010, 107, 11155–11162

3Ss for water **Store – Sensitive – Smart**

Average rainfall 1085 mm, 85th in a list of 186 countries

Traditions of storage and conservation – we store just about 8%

Water is for all – for every living form

83% of freshwater species have declined globally in the last 50 years!

GDP can grow even by capping freshwater withdrawals

We must find technologies of relevance

Energy - food – clothing – construction – manufacturing -

Water is big in every scale – Gaps, opportunities, wealth, satisfaction

Building capacity

SYMPOSIUM ON

Imagining India@2047 through Innovation

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Thank you all

