

Since 1959



Afford



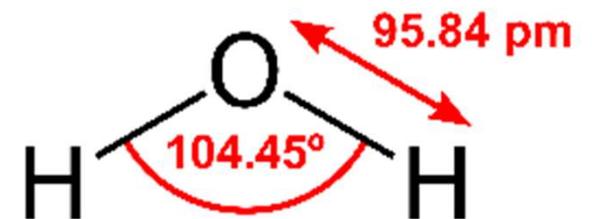
rials

Professor-in-charge

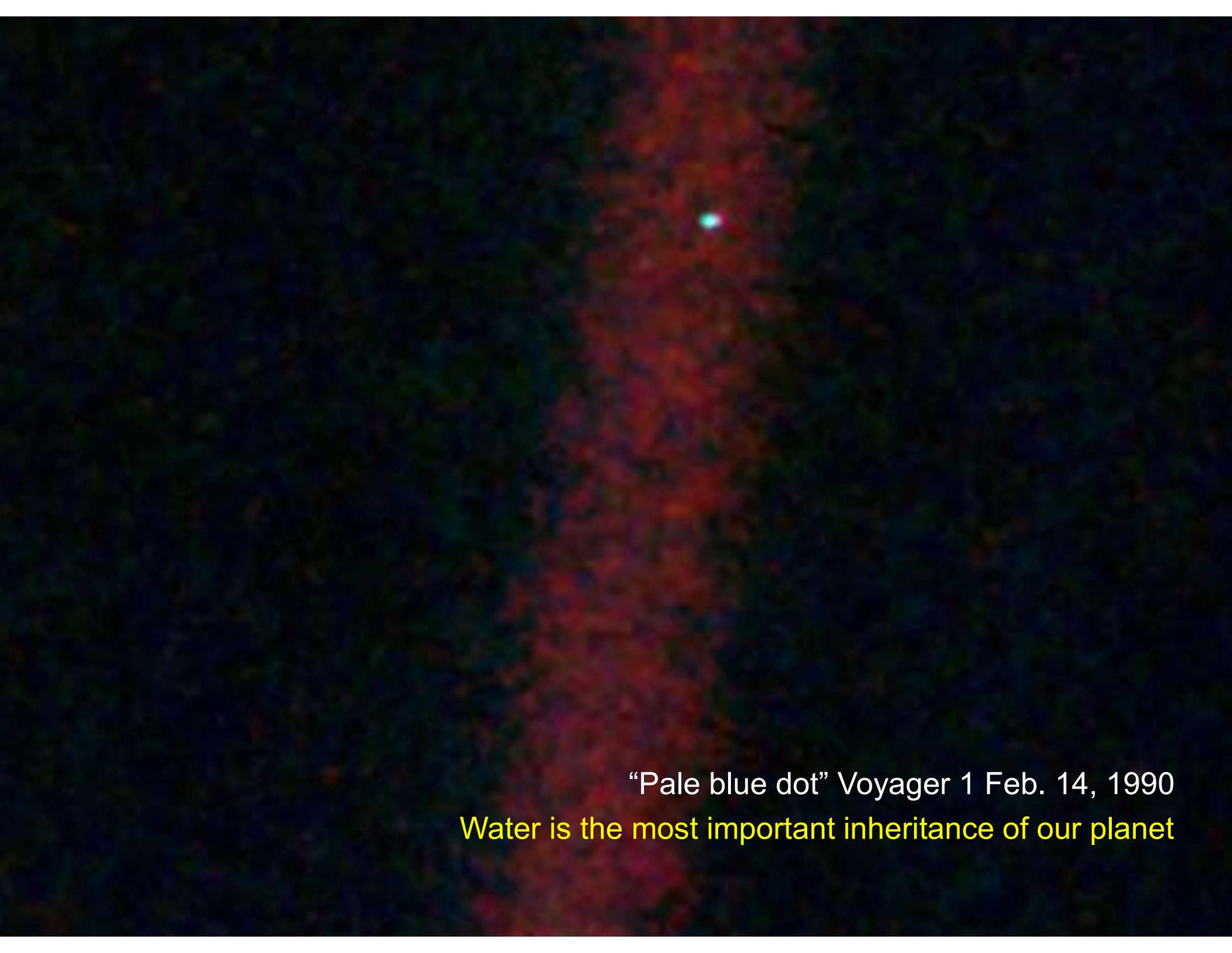
Prof. P. Padmaja and colleagues



International Centre for Clean Water



The Maharaja Sayajirao University of Baroda, Vadodara, June 5, 2022 (online)



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

Water is the most important inheritance of our planet

# Water is at the centre of action

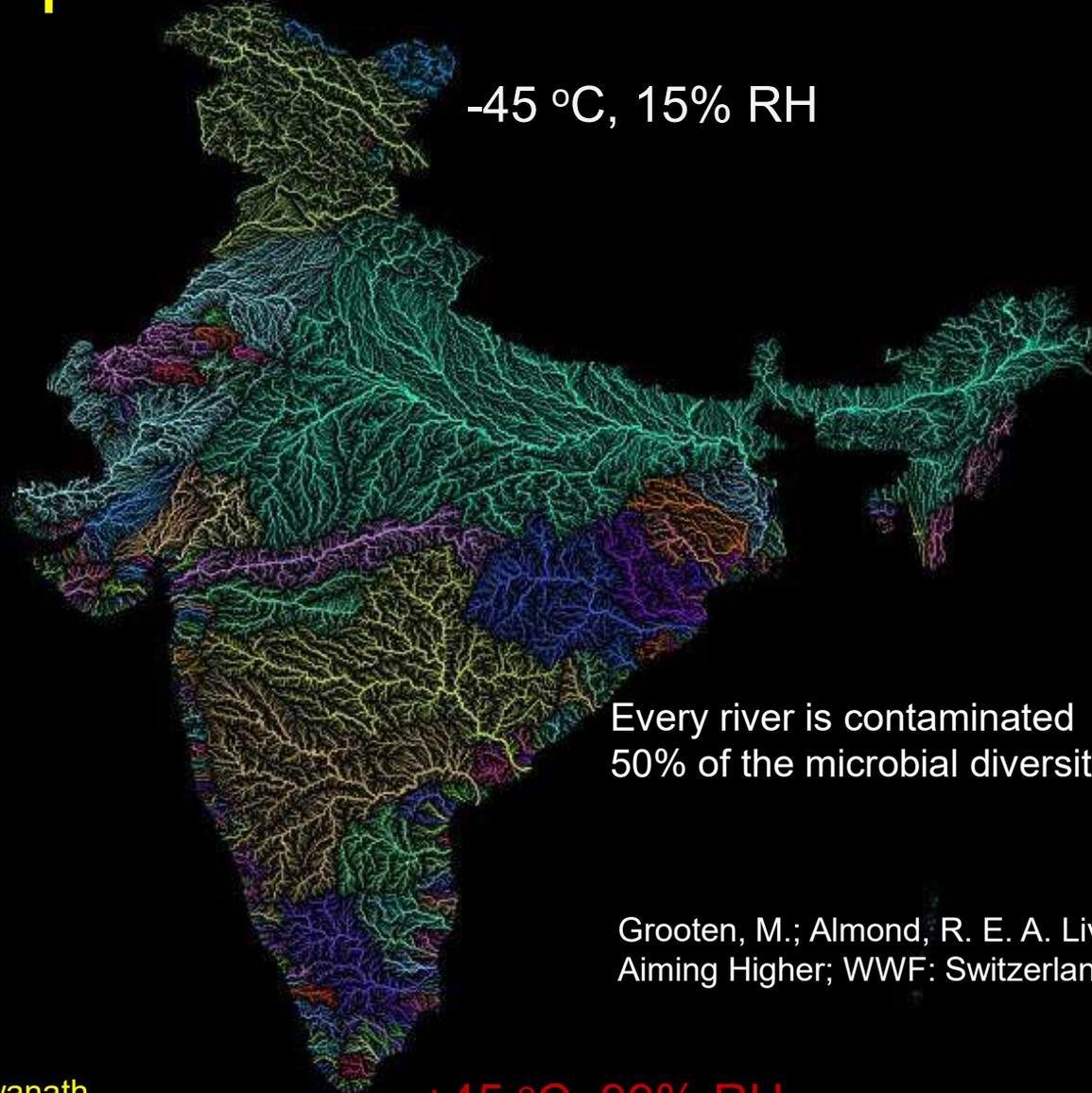


Variety and diversity are part of water, in problems and opportunities

# Challenges

## Every possible need

Arsenic  
Fluoride  
Uranium  
Mercury  
Chromium  
Perchlorate  
Nitrate  
Pesticides  
Antibiotics  
Plastics  
Detergents  
.....



-45 °C, 15% RH

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

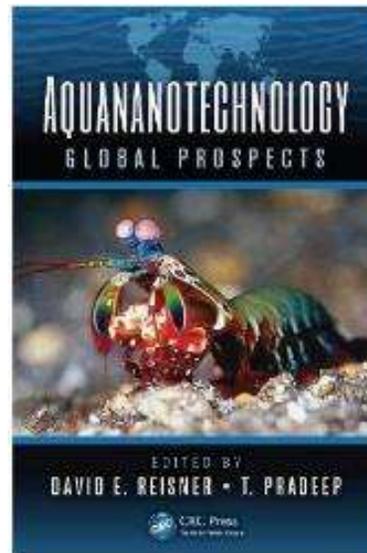
Grooten, M.; Almond, R. E. A. Living Planet Report - 2018:  
Aiming Higher; WWF: Switzerland, 2018.

+45 °C, 99% RH

From S. Vishwanath

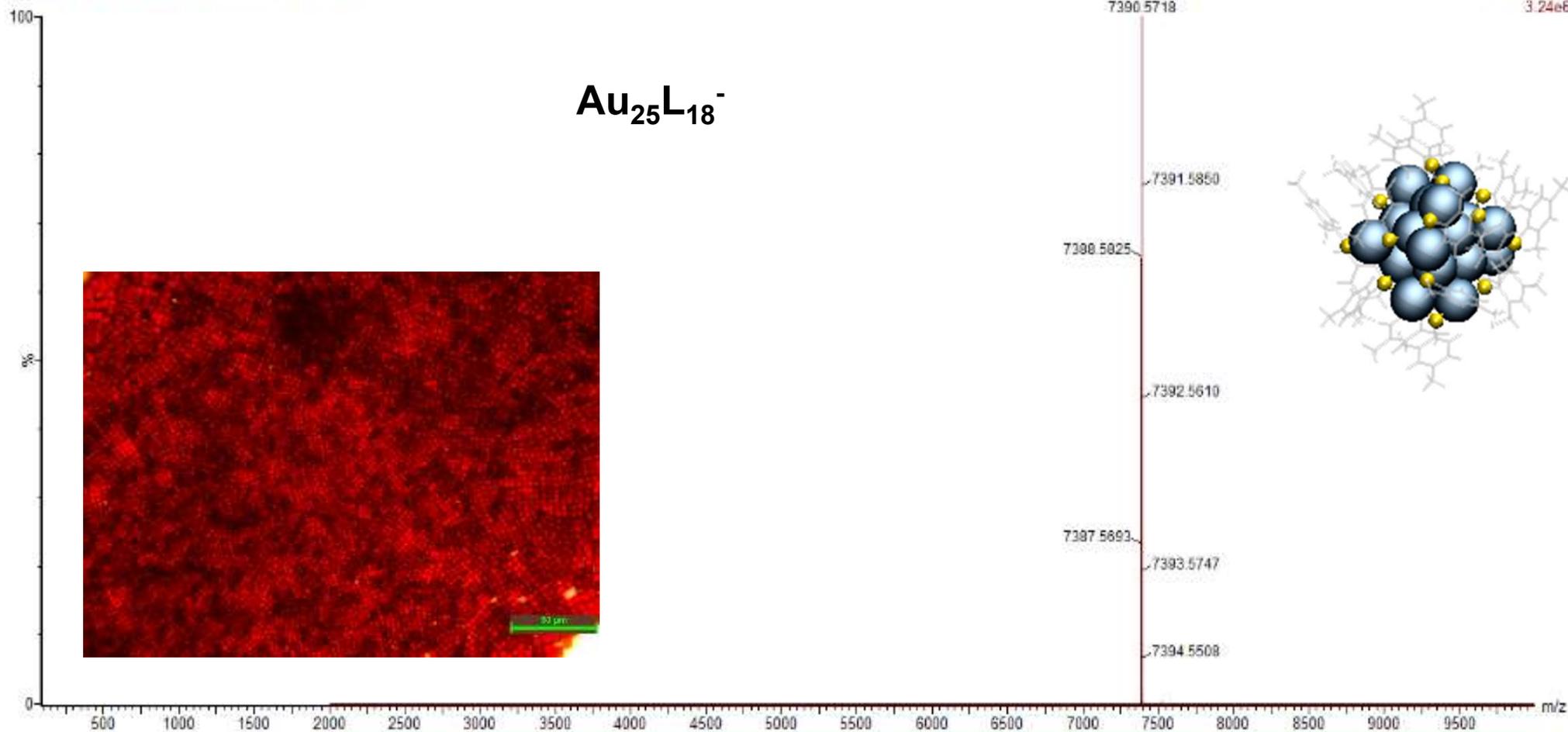
# Affordable clean water is a problem of advanced materials

- New adsorbents
- New sensors
- New catalysts
- Novel phenomena
- New devices



# Nanomaterials are now atomically precise

AU25PET16\_RES\_NEG\_MS\_3 32 (0.658) Cm (5:00)



# Nanomaterials can solve real problems



ACS Sustainable Chemistry & Engineering Editorial, December 2016

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

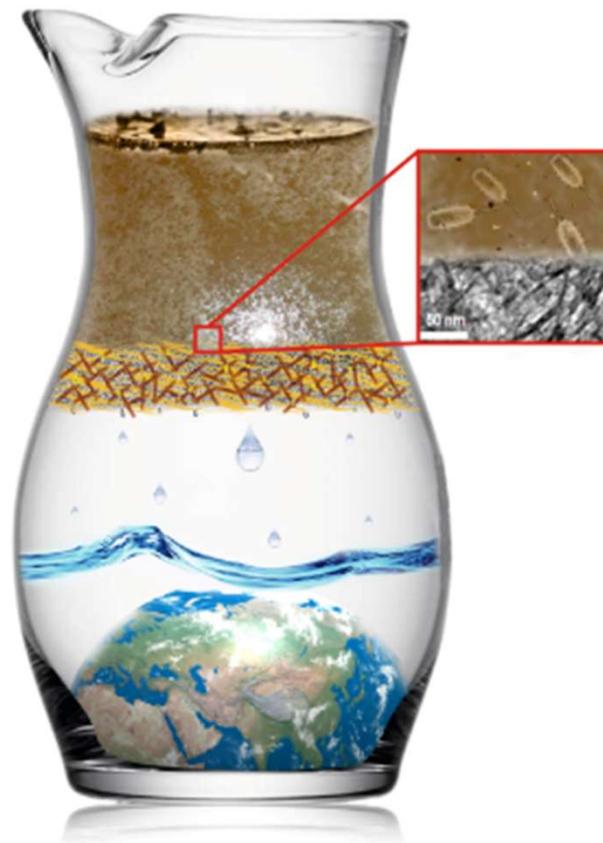
Mohan Udhaya Sankar<sup>1</sup>, Sahaja Aigal<sup>1</sup>, Shihabudheen M. Maliyekkal<sup>1</sup>, Amrita Chaudhary, Anshup, Avula Anil Kumar, Kamalesh Chaudhari, and Thalappil Pradeep<sup>2</sup>

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 in rural areas. The ability to purify water at ambient temperature is a significant advantage for water purification in rural areas.

hybrid | green |



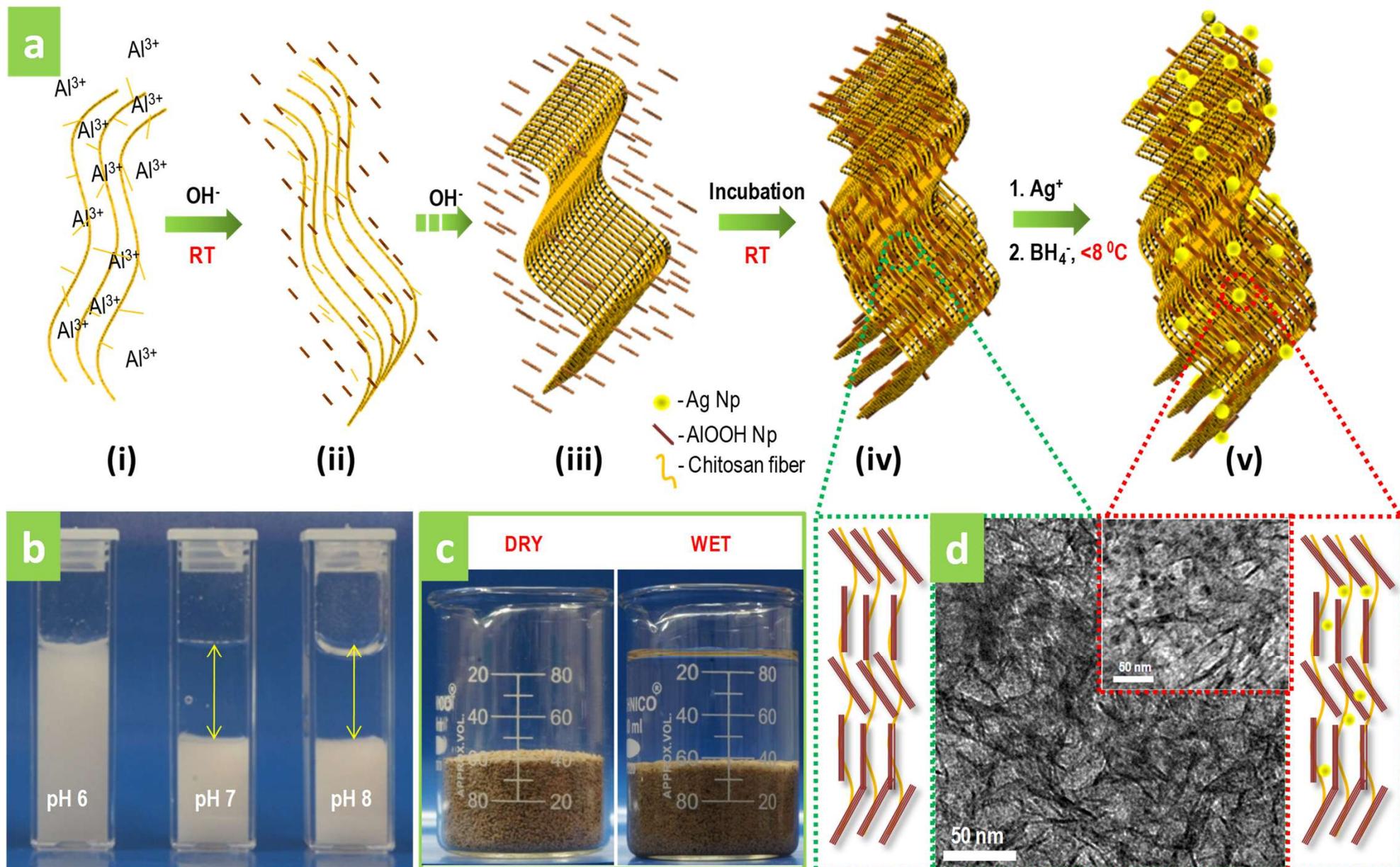
release into water are not available; and (c) continued retention of the nanoparticles in the matrix is difficult.

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

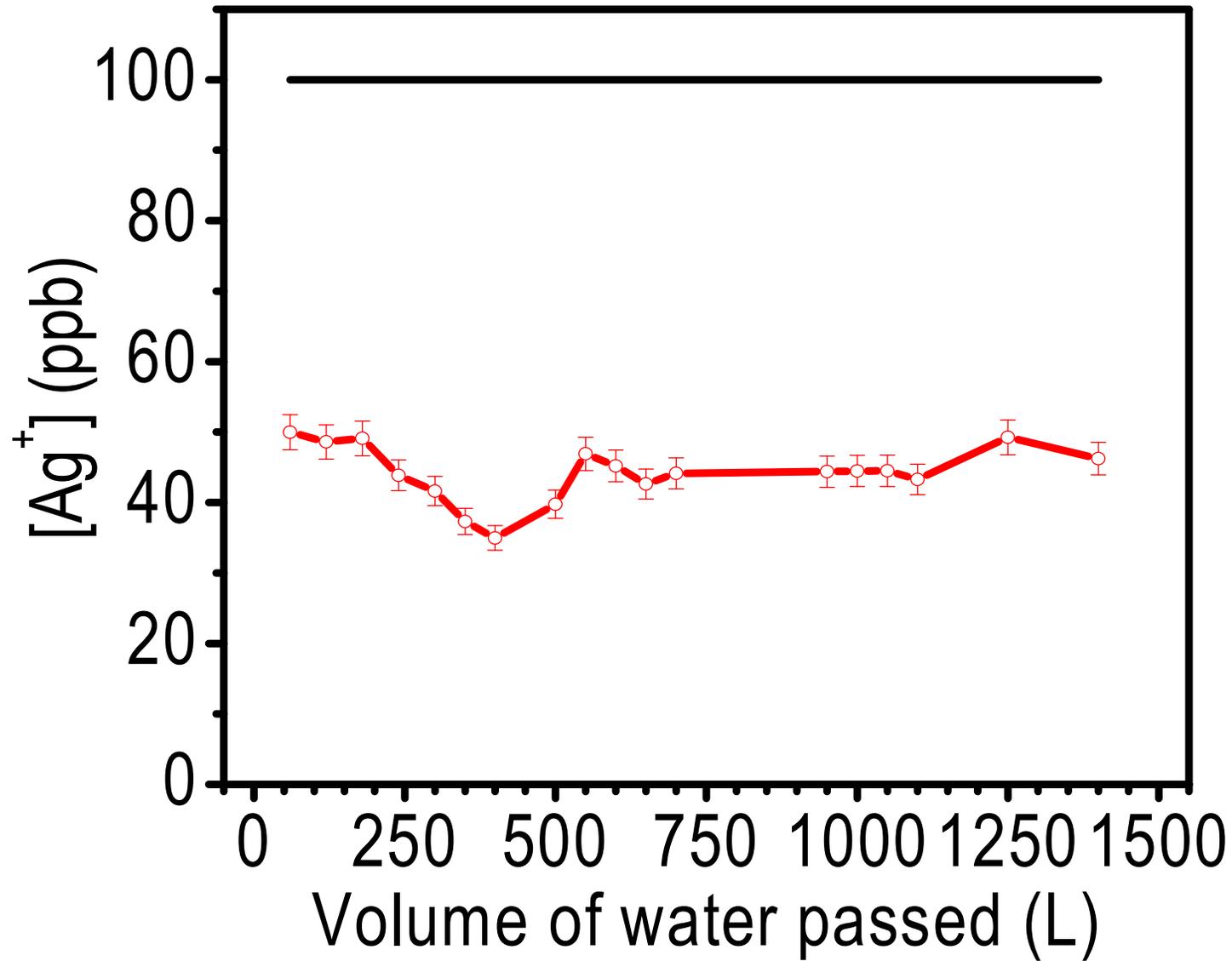


# New materials



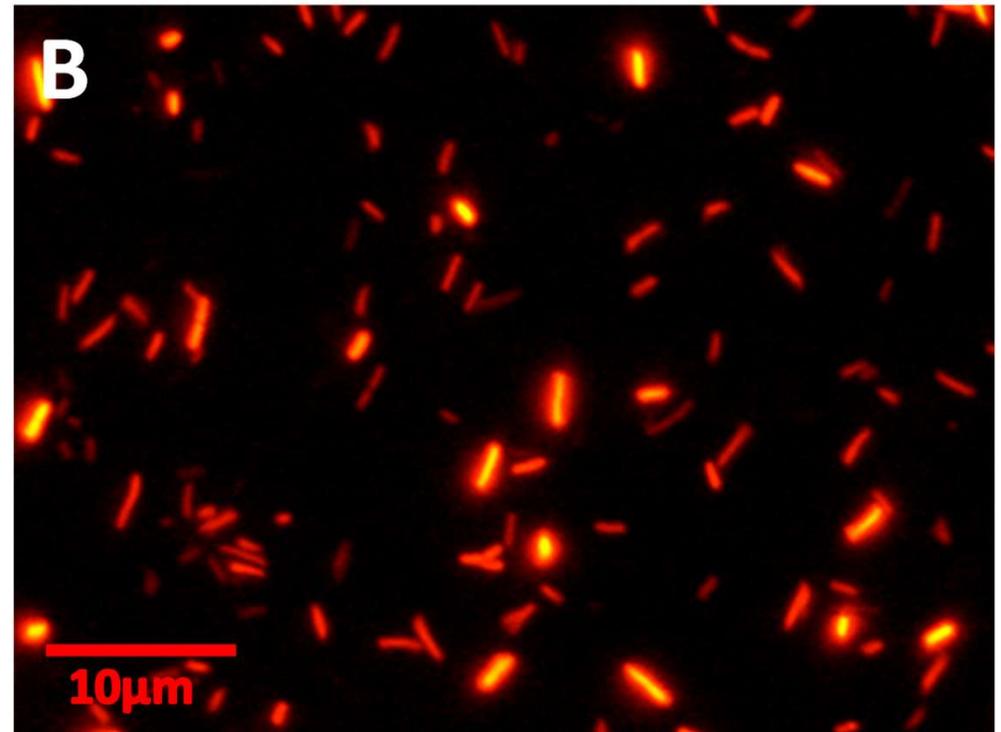
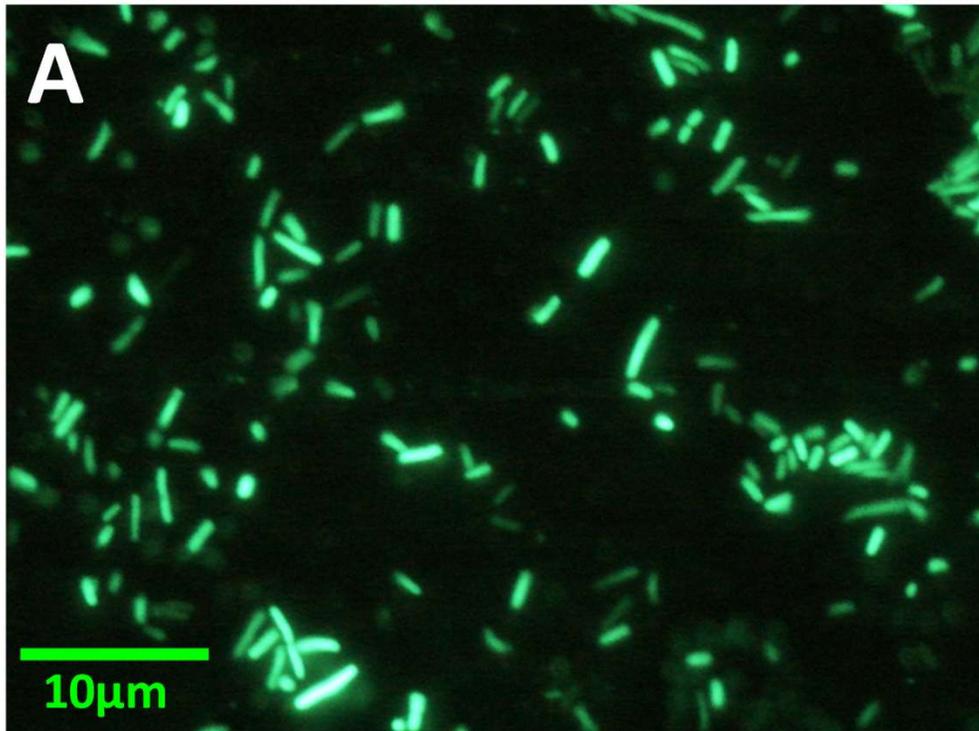
# What is special?

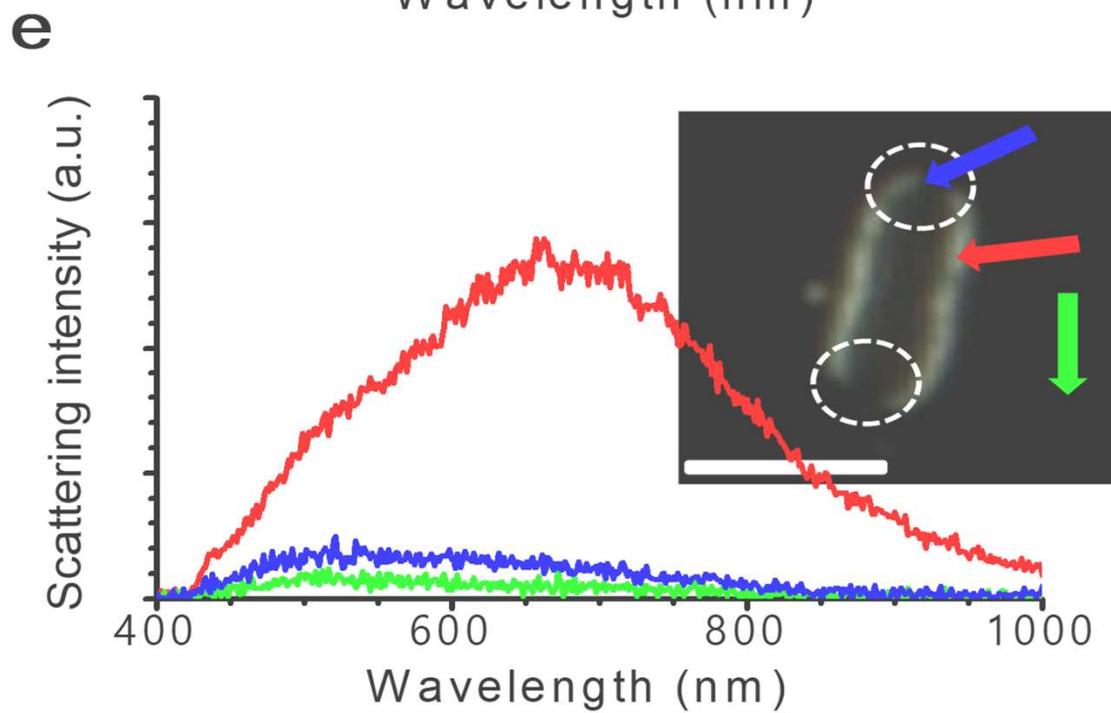
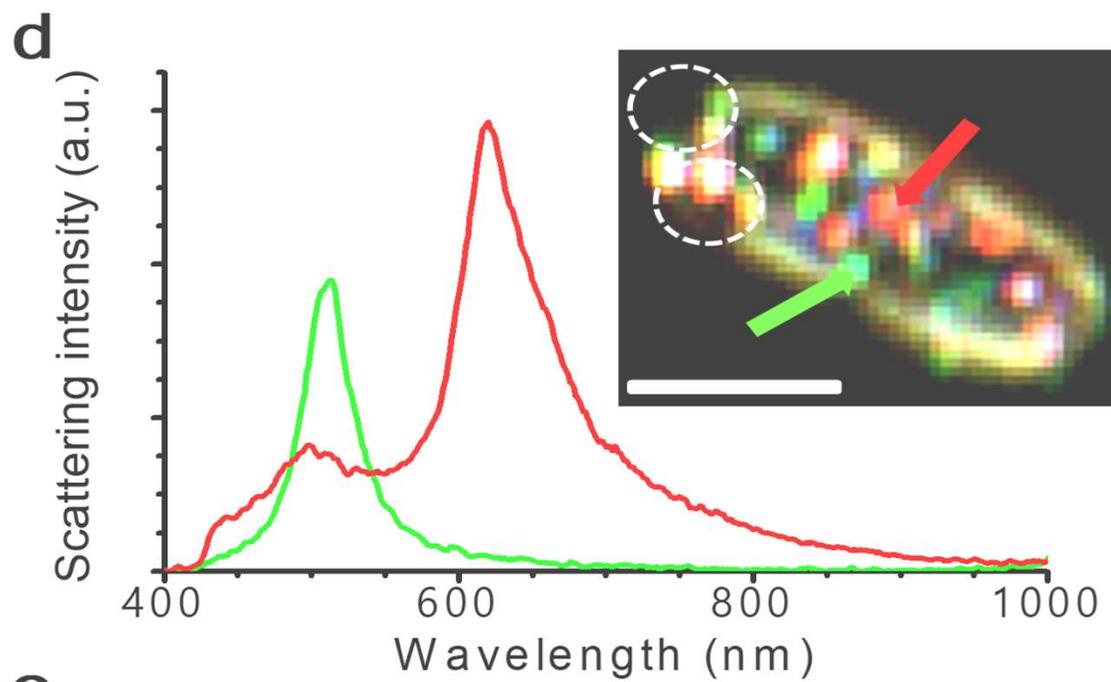
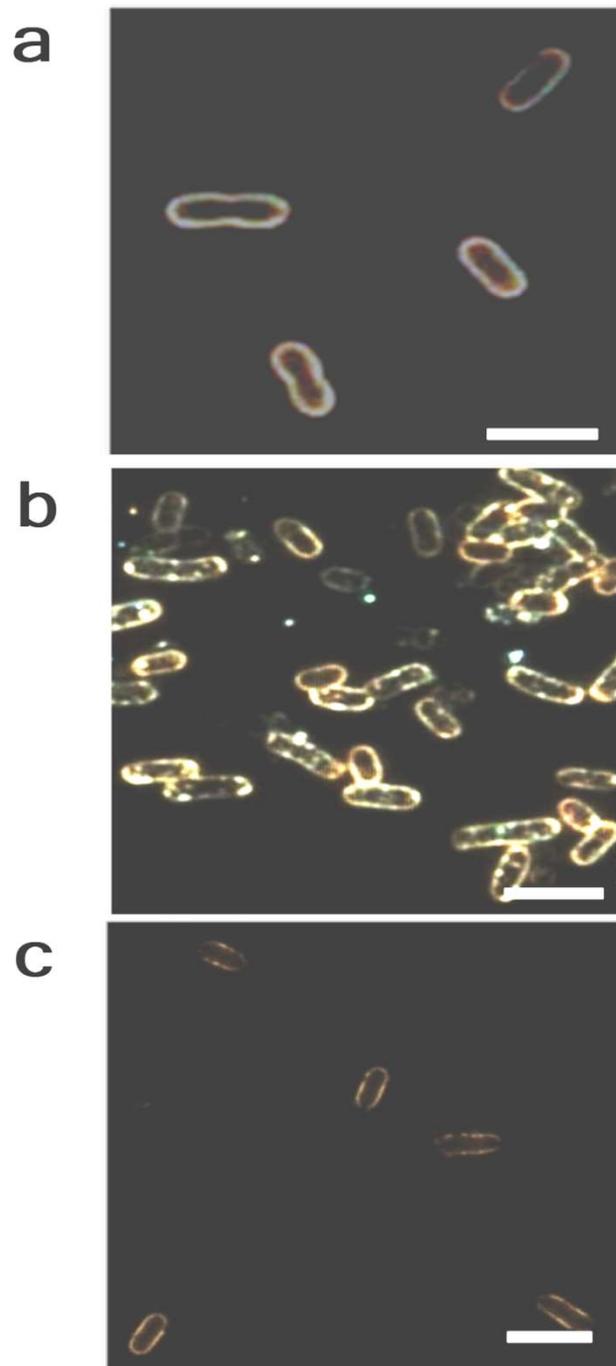
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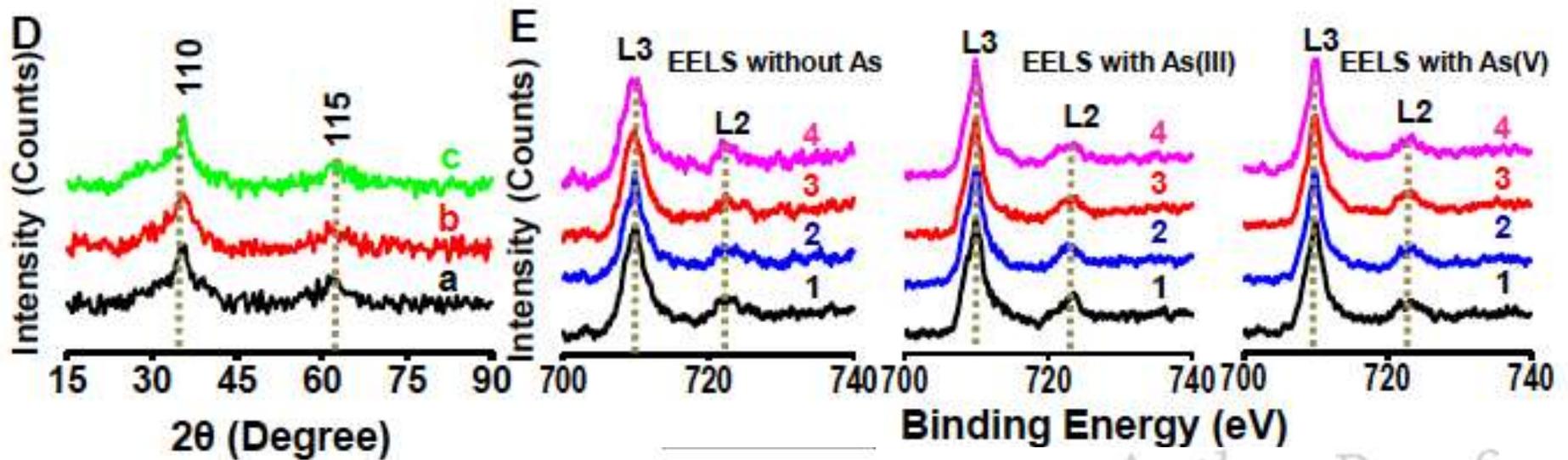
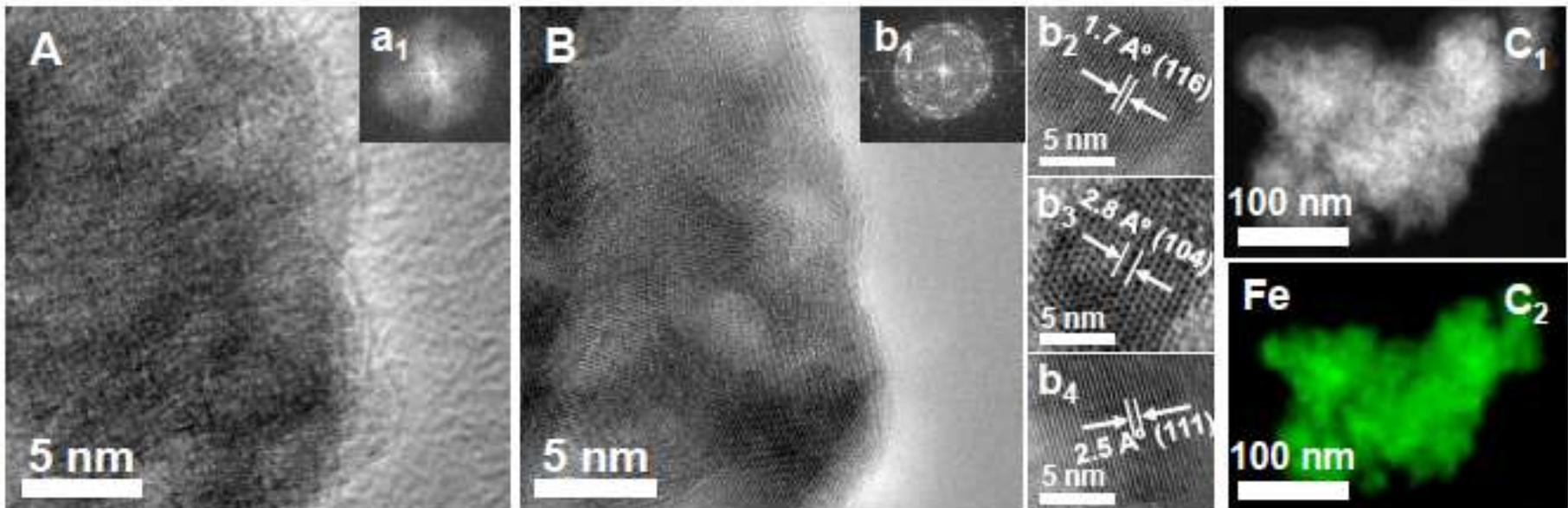


# Live/dead staining experiments

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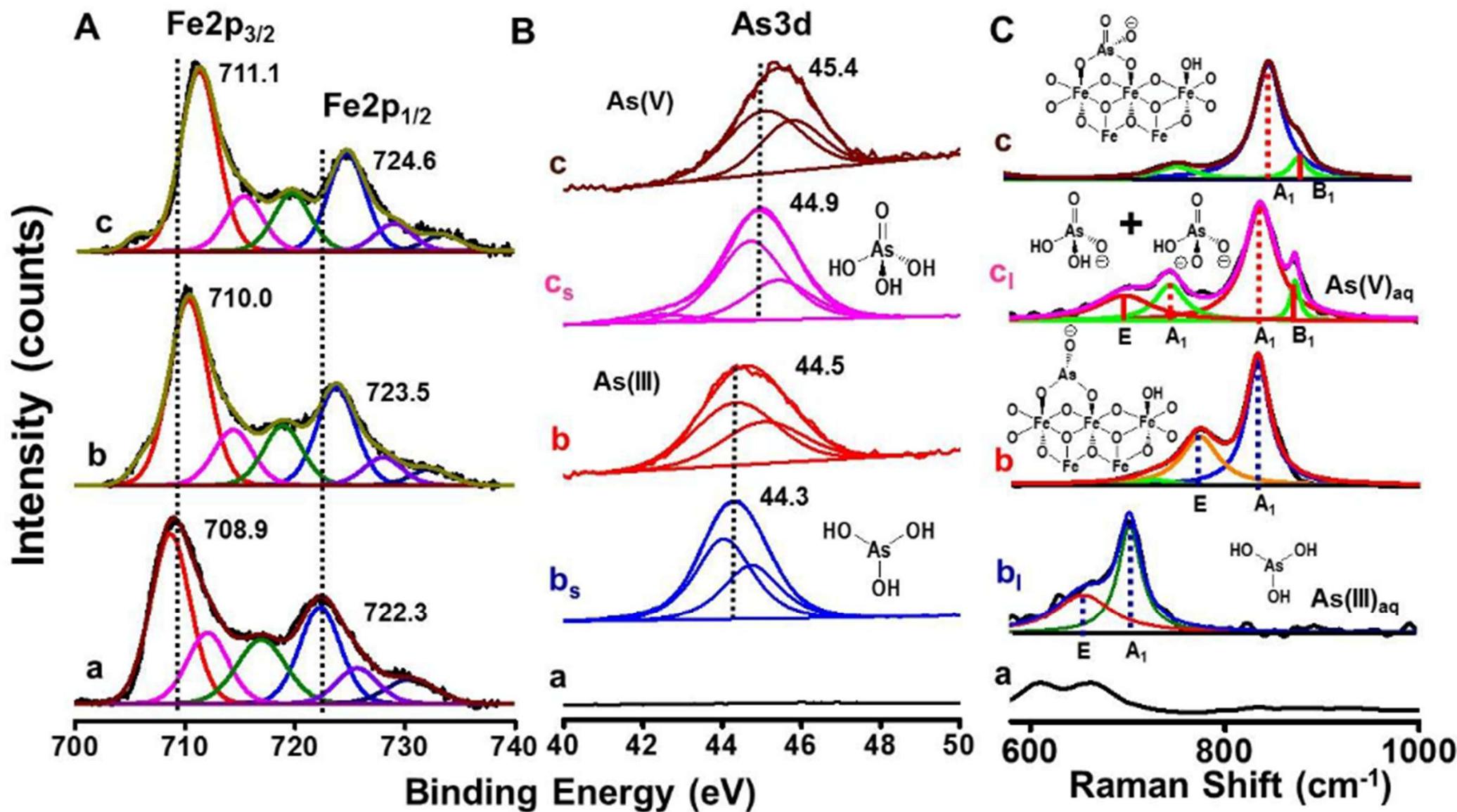
www.advmat.de

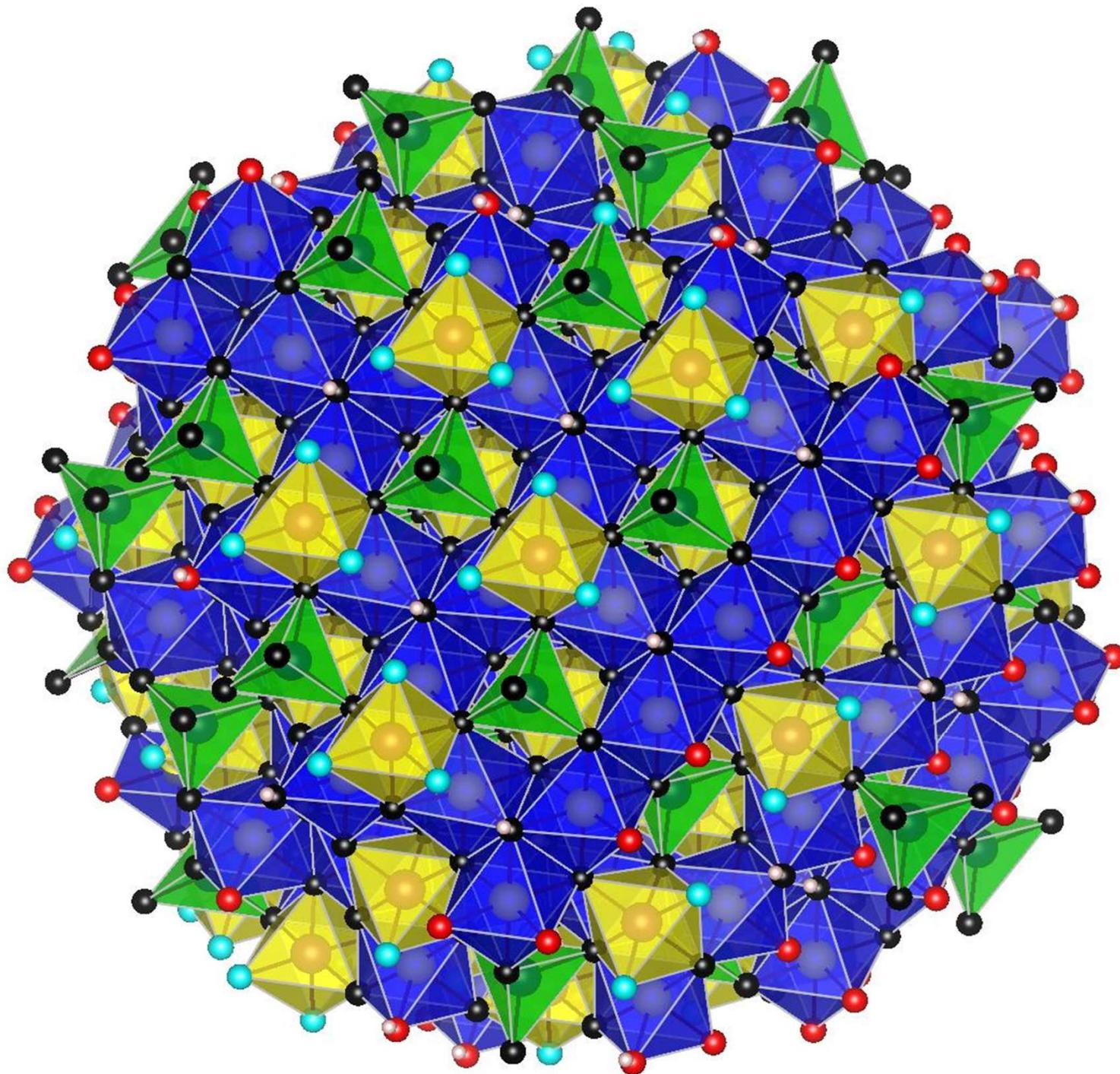
Author Pr <sup>6</sup> ADVANCED MATERIALS

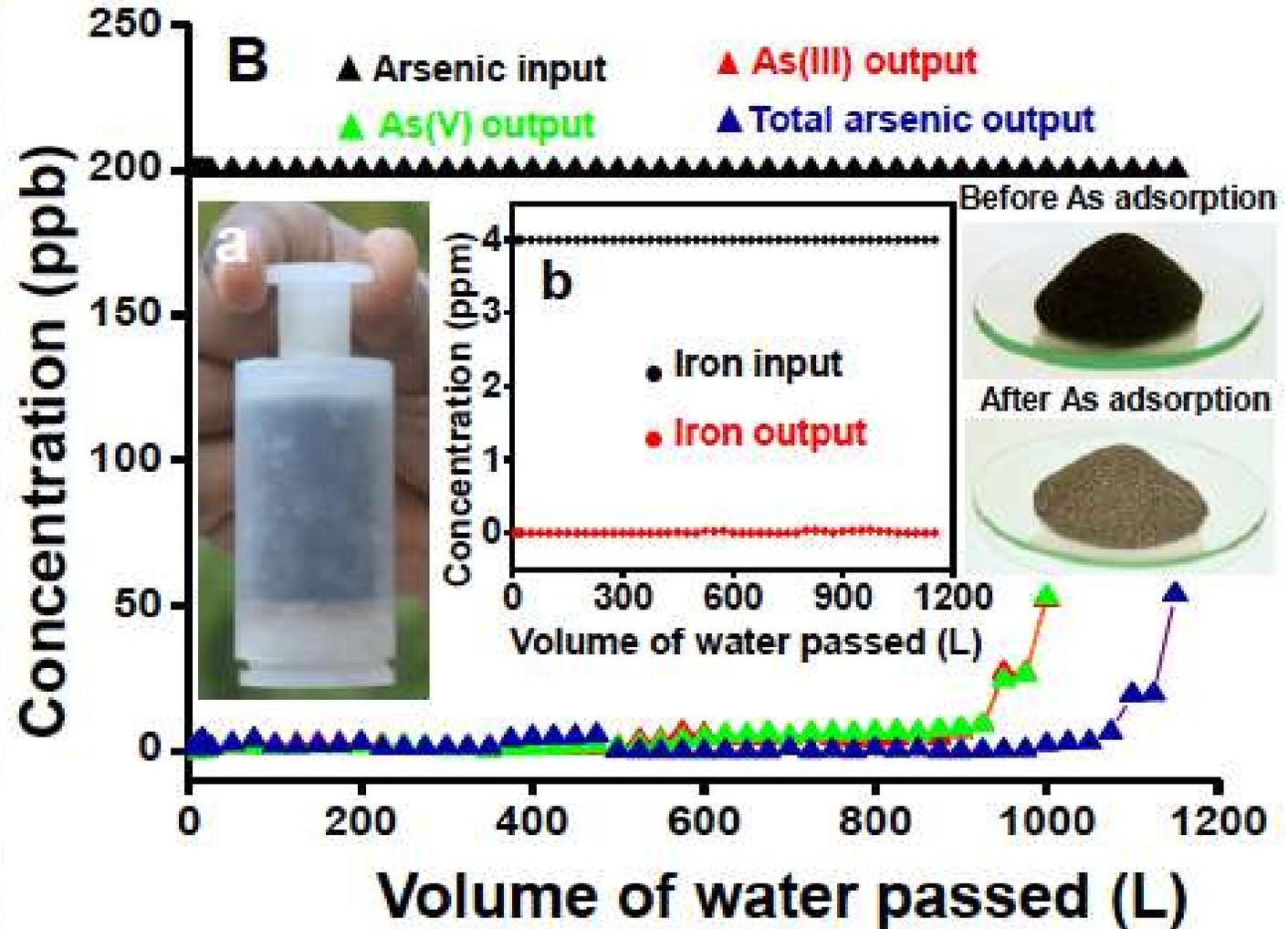
## Confined Metastable 2-Line Ferrihydrite for Affordable Point-of-Use Arsenic Free Drinking Water

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\*

# Mechanism







# Changing the dynamics in the field



Existing plant in 40 cents



New plant in 3 cents

- Existing unit for iron and arsenic removal – 20 m<sup>3</sup>/h
- Uses activated alumina and iron oxide (old generation of adsorbents)

- Existing unit for iron and arsenic removal – 18 m<sup>3</sup>/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)

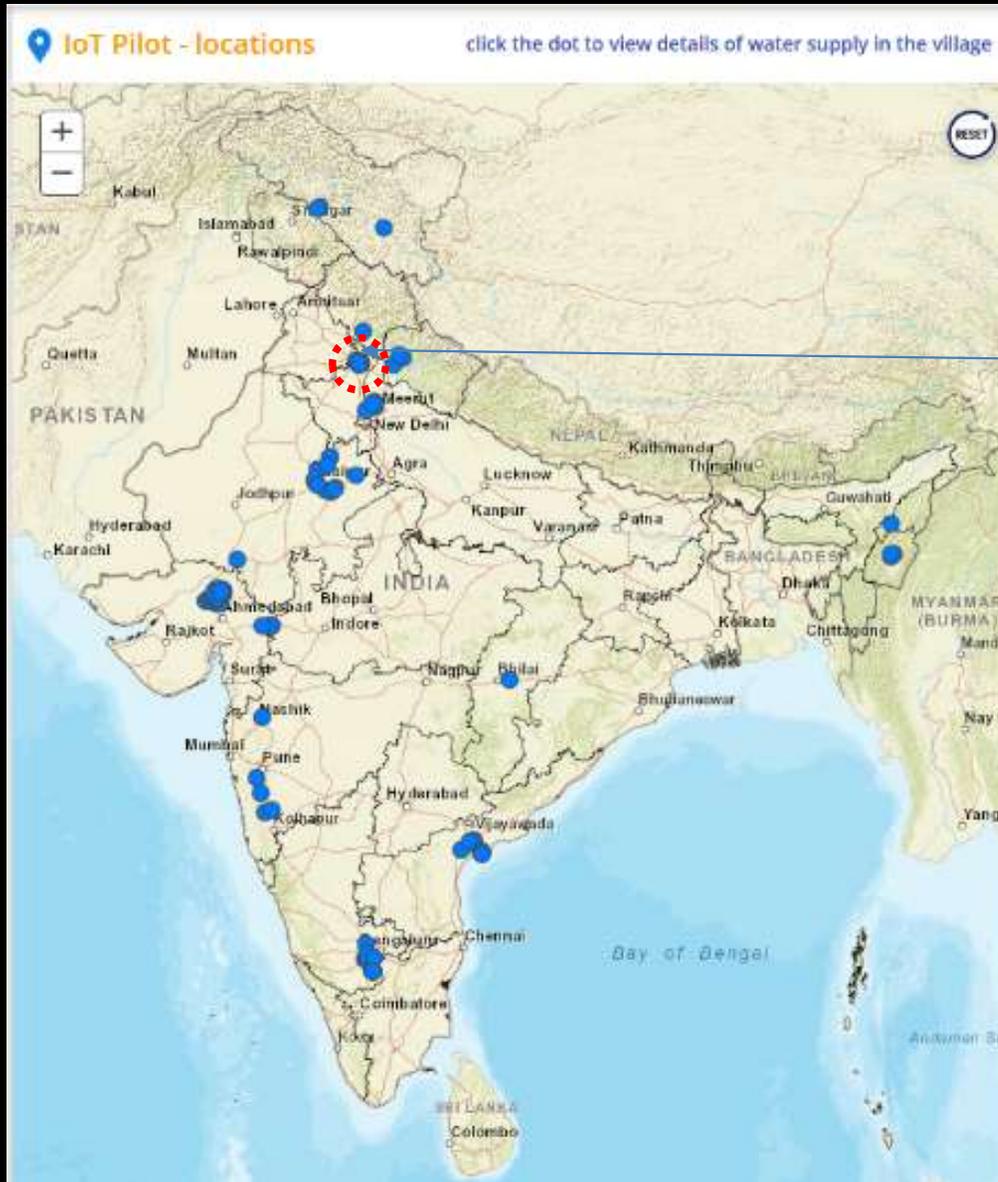


Name of the scheme: Mahilan Wala (TW9144), District: Amritsar  
Population: 2610, Daily demand@70 LPCD: 188 kLD, OHSR Capacity:  
100 kL



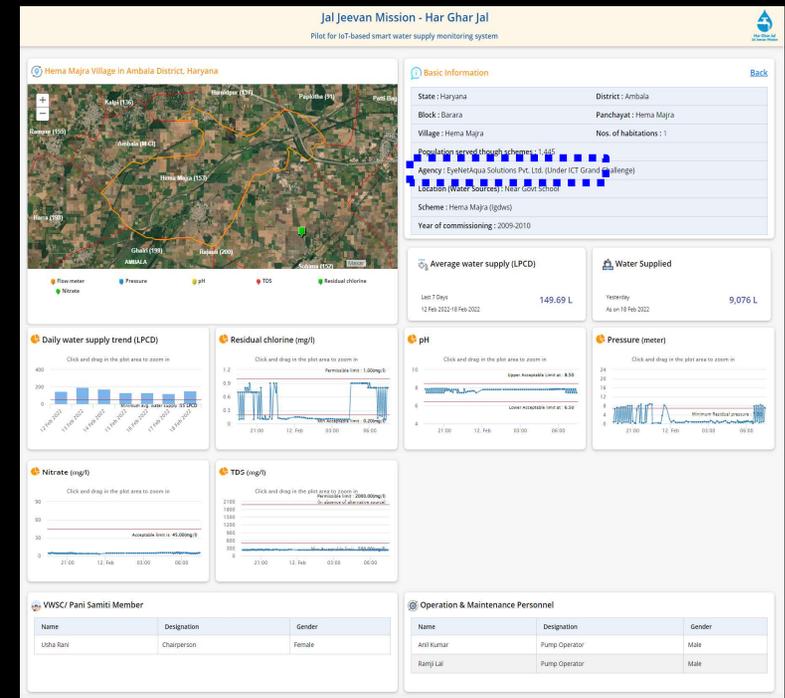


# India's water is being monitored



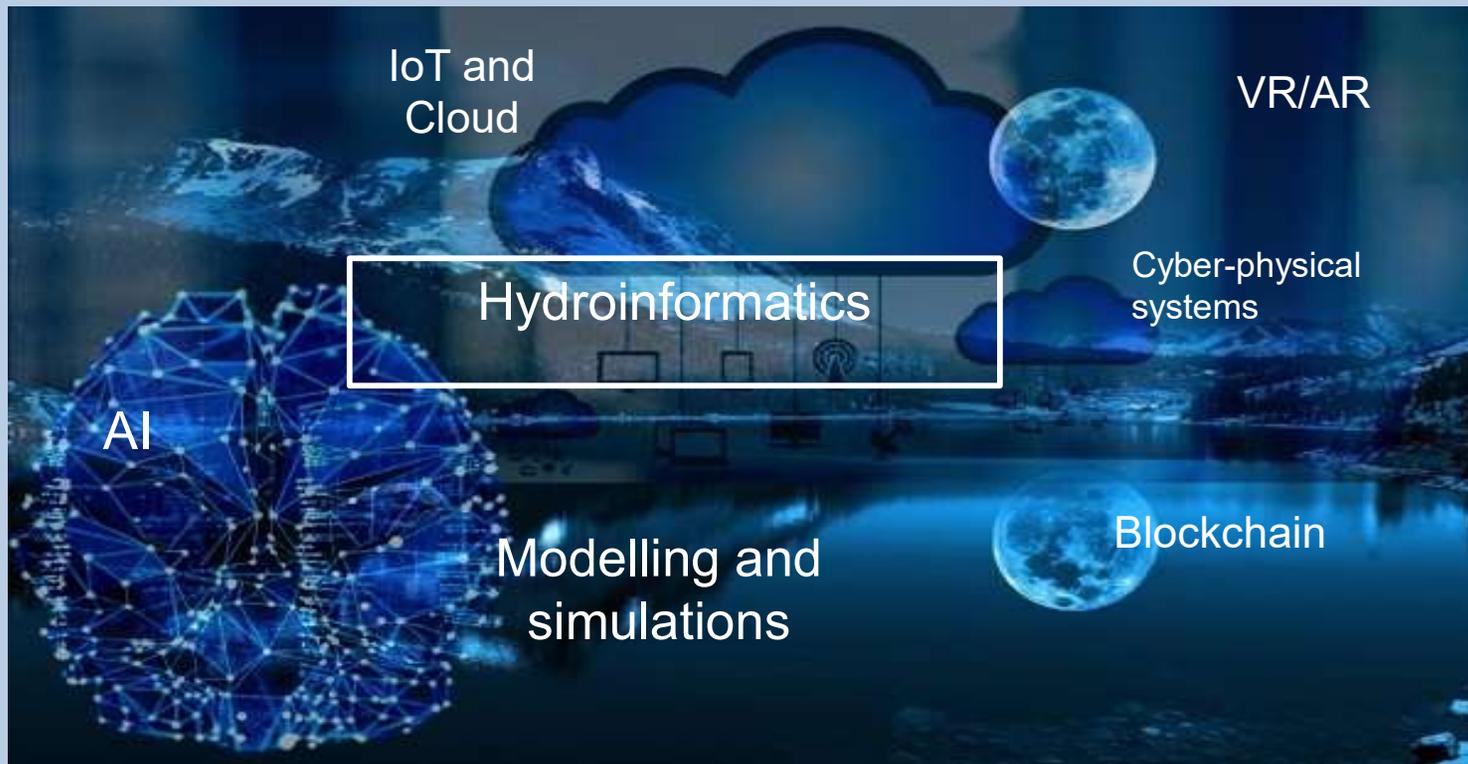
IITM/IISc

Installations made by four companies



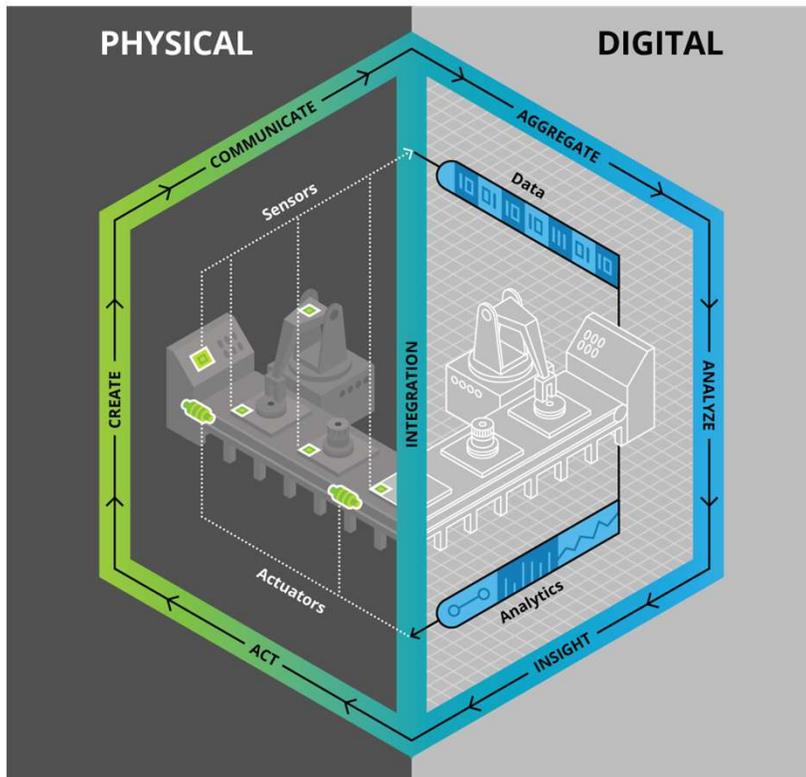
# Hydroinformatics

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



# Water 4.0

## Digital twin of water resources



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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.

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# Traditional knowledge

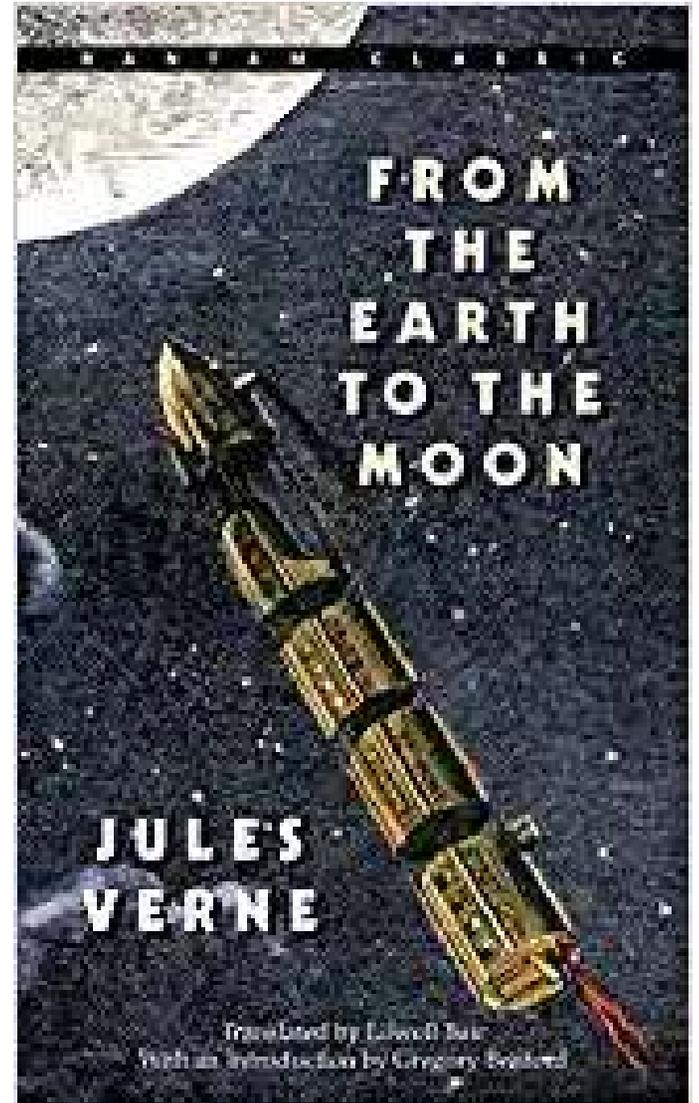
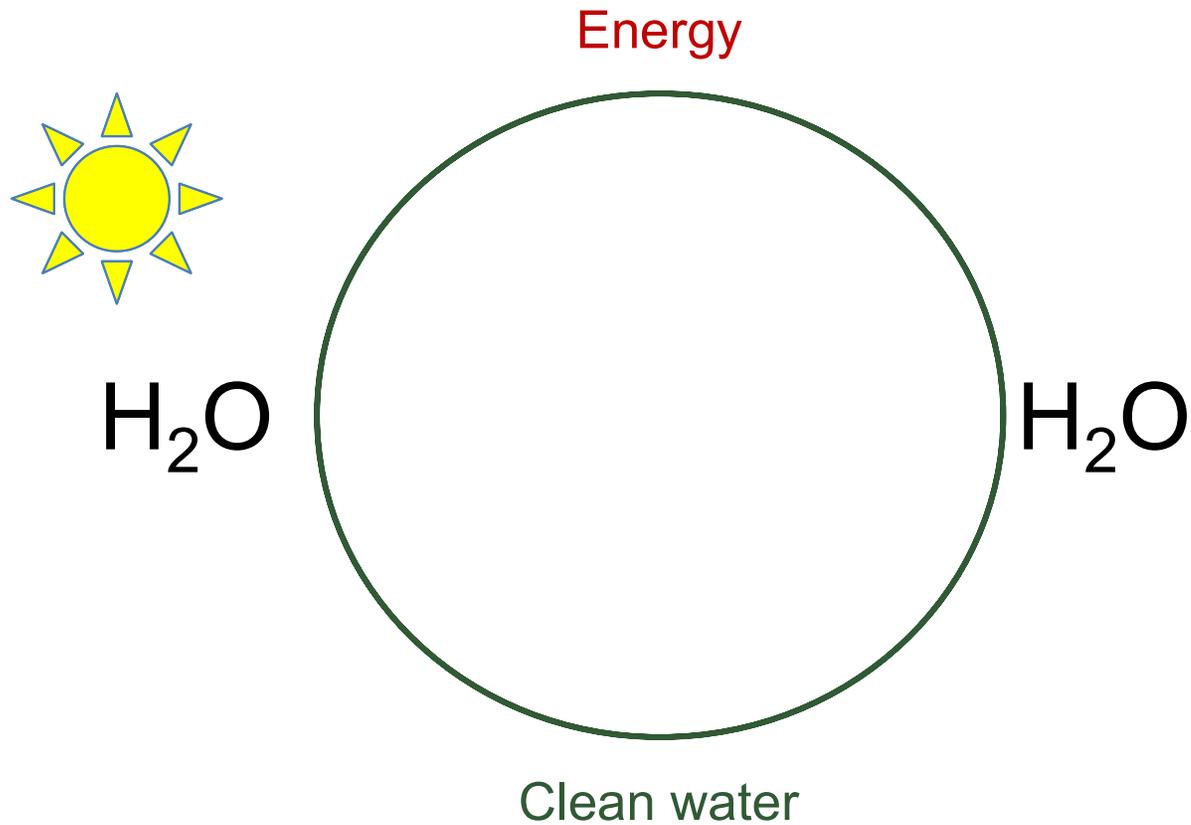


<https://www.unnatisilks.com/blog/naturally-colored-cottons-a-regain-in-popularity/>



Policy

Our dreams become reality with materials



Affordable, inclusive, sustainable and contextual excellence

## Some simple calculations

Hydrogen + Oxygen → Water + 286,000 joules of energy per mole

1 kg of solar hydrogen is now at Rs. XX and could be Rs. 150 soon.

It can make 143 million J of energy.

Desalination needs 2.4 kWh or 8.84 million joules for 1 CM of water.

1 kg of hydrogen can therefore make 16.56 CM of water.

Or Rs. 9.06 per cubic meter, 0.9 paise per litre!

Well, add efficiency, other costs of plant, transportation, etc.

That world will need water literacy



# Indian Institute of Technology Madras



Directors - past and present

# Thank you all



Associate Editor

ACS  
Sustainable  
Chemistry & Engineering

