Andrea Fratalocchi

CEMSE

Primalight group; www.primalight.org

PI's photo

Study of complex systems for developing technologies in clean energy harvesting, healthcare, cryptosecurity and advance materials

Keywords:

Clean energy harvesting (photocatalysis, solar CO2 reduction, solar water splitting, solar desalination), nanomaterials (complex metasurfaces)
artificial intelligence (machine learning, cognitive AI on-chip)
Nanomedicine (nano-imaging, bio-sensing)
Perfect Secrecy (large scale unbreakable cryptography)

Research in collaboration with Industry (US/EU), and Academia (US/EU/ASIA)

Twitter account

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جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology

CEMSE Computer, Electrical and Mathematical Sciences and Engineering

Research

- ✓ Energy harvesting: We research on new energy harvesting processes for light trapping and energy storage, solar production of chemical fuels, solar desalination, solar steam generation, and carbon negative technologies.

- ✓ Advanced materials: We research on complex materials that control broadband light at the nanoscale with applications in perfect black-body absorbers, structural coloration, and light wavefront engineering.

- ✓ Artificial intelligence (AI): We research on exotic light states (Anapoles and general radiation-less states) and a new generation large-scale artificial intelligent cognitive devices, including new forms of optical neurophotonics integrated chips for low-power and efficient AI on-chip.

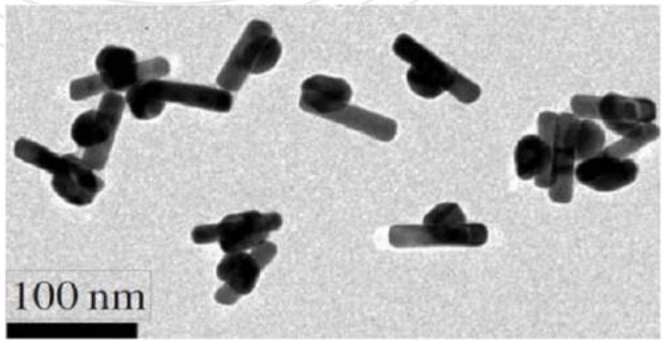
- ✓ Nano-Imaging: We research on complex bio-imaging devices with applications ranging from enhanced surface enhanced Raman scattering (SERS), high resolution multicellular spectroscopy, and nanoscale bio-sensing

- ✓ Perfect secrecy: We research on new scalable and CMOS compatible optical platforms for information security via perfect secrecy, i.e., unbreakable cryptography, in ultrafast classical optical communication systems.

Applications

Advanced materials: some highlights

✓ World record ultra-dark optical materials for different applications



Nature Nanotechnology **11**, 60–66(2016)

CHEMISTRY WORLD

Blackest material ever made sets new record

BY DAVID BRADLEY | 21 OCTOBER 2015

The dark tricks of nanotechnology

nature middle east

NewScientist

Super-dark chameleon material shifts colour to boost solar power

Mail Online

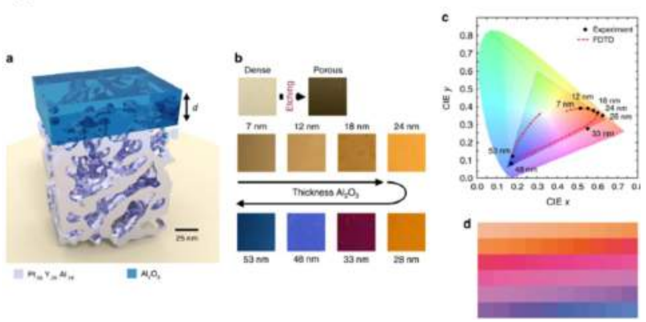
Black just got blacker: Scientists create the darkest material ever made using microscopic rods and spheres

- The super-black material is made from a nanorod attached to a nanosphere
- It absorbs up to 99% of of light across the visible and infrared spectrum and 26% more light than the current blackest material - carbon nanotubes
- This absorption rate also isn't affected by the angle of the light
- The material could be used to harvest energy and on sensitive telescopes

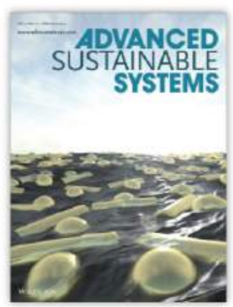
PHYS ORG

Researchers create blackest material ever made

Examples of applications in structural colors & water desalination



Light: Science & Applications **6**, e16233(2017)



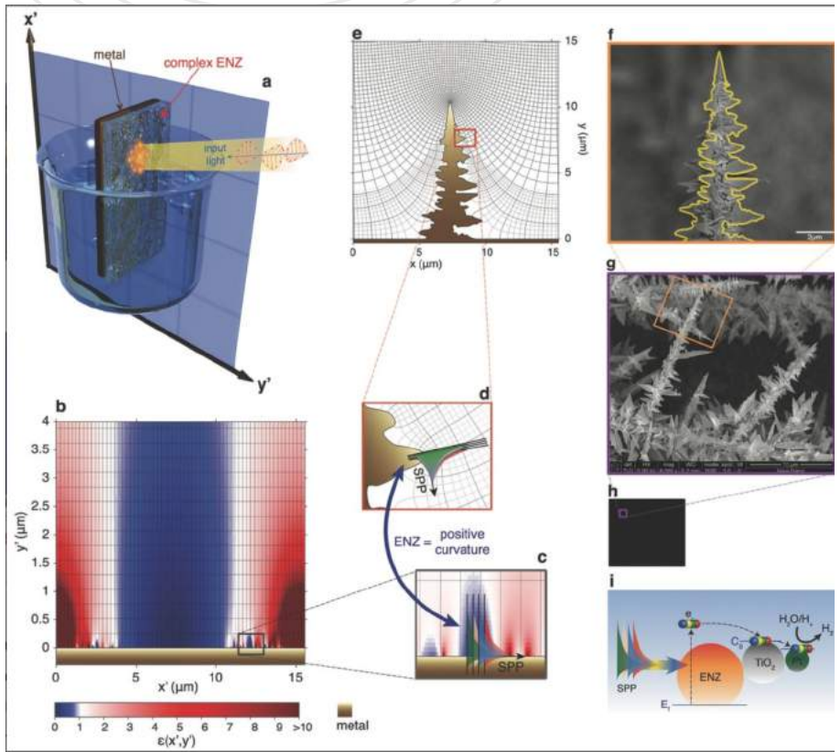
Volume 1, Issue 1-2

February 2017

Applications

Energy Harvesting: some highlights

✓ World record efficiency in plasmonic photocatalysis for hydrogen production



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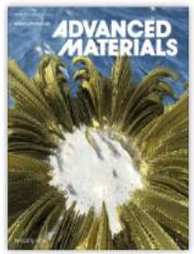
AUGUST 29, 2017

Tripling the efficiency of solar-based hydrogen fuel generation with metallic nanostructures that slow down light

nanowerk

Posted: Aug 28, 2017

Nanostructured dark materials squeeze green fuel from sunlight



Volume 29, Issue 27

July 19, 2017

1701165

Green Car Congress

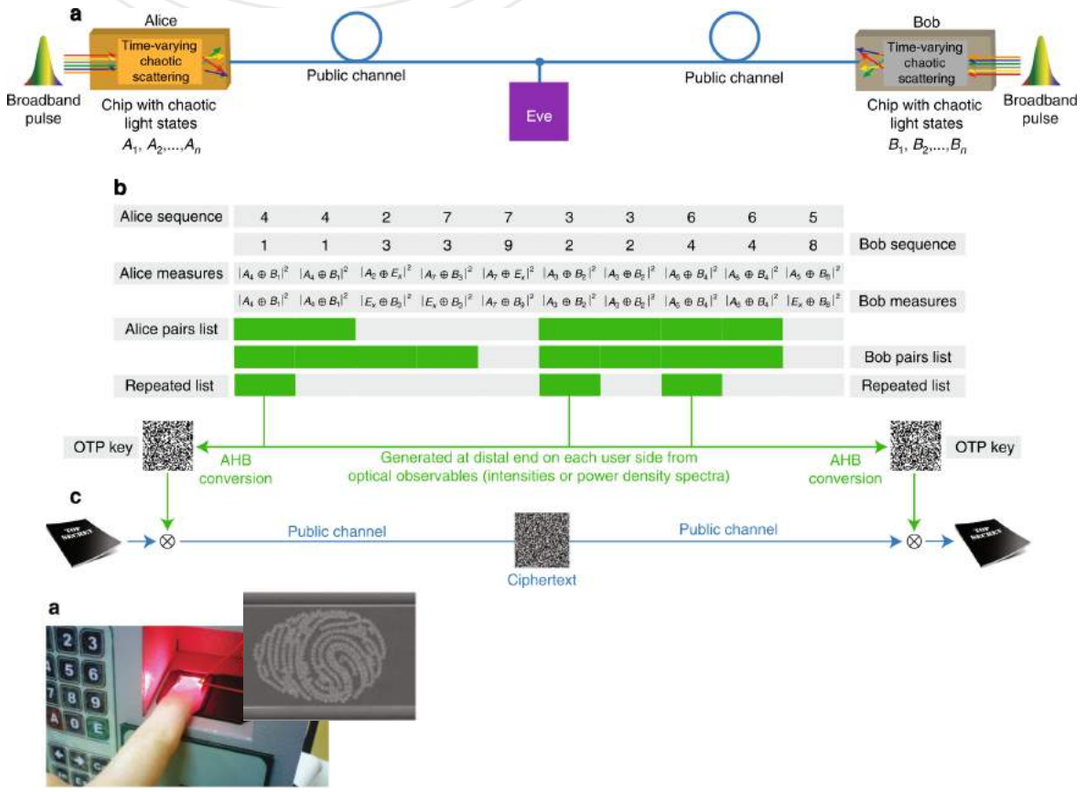
Energy, technologies, issues and policies for sustainable mobility

Metallic nanostructures with strong light confinement can triple the efficiency of solar-based hydrogen generation

Applications

Perfect secrecy: some highlights

- ✓ First realization of unbreakable cryptography on a classical optical system ever reported. (Patented technology)



Nature Communications **10**, Article number: 5827 (2019)

Forbes

18 views | Dec 20, 2019, 11:26am EST

Scientists Develop 'Absolutely Unbreakable' Encryption Chip Using Chaos Theory

Forbes · OPTICS & PHOTONICS · techradar pro · University of St Andrews | 1413 | News · The Telegraph · TechXplore

Business Wire · yahoo! finance · ITProPortal · CONTINUITY CENTRAL.com · REACTIONARY TIMES · StarRadarOnline

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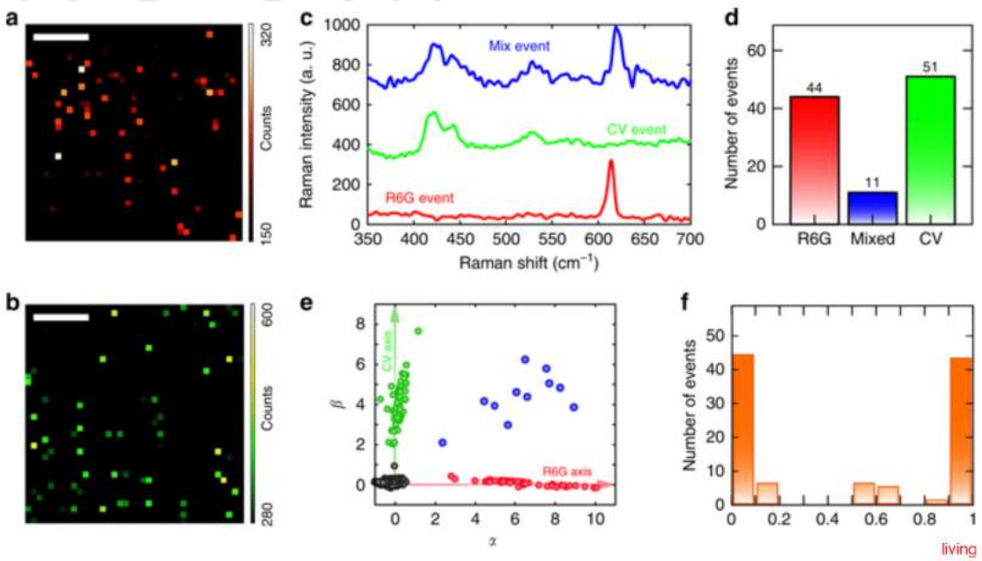
THE QUBIT REPORT · London Globe · KAUST Discovery · INDEPENDENT · AsiaNewsDay · deadline.

ARAB NEWS

Applications

Bio-Imaging: some highlights

✓ Ultrafast broadband single molecule imaging



Nature Communications **9**, Article number: 5428 (2018)

nature nanotechnology

Research Highlight | Published: 05 February 2019

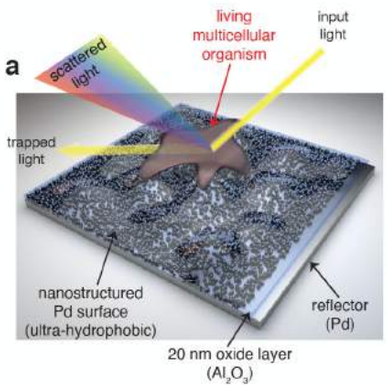
SURFACE-ENHANCED RAMAN SPECTROSCOPY

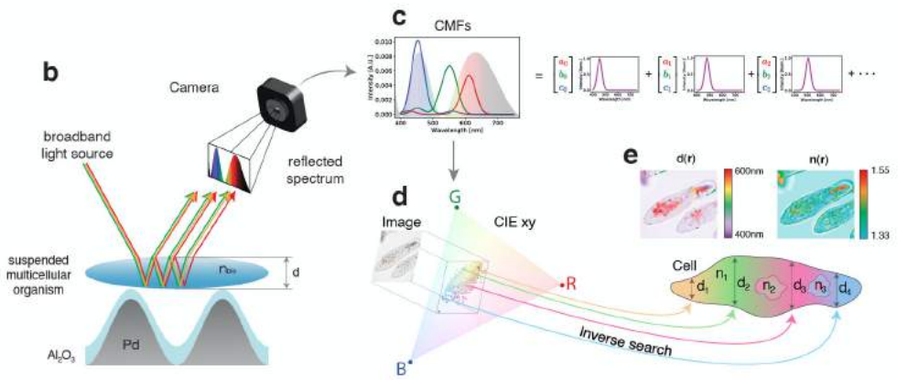
Curved space for fast analysis

Alberto Moscatelli

Nature Nanotechnology **14**, 100 (2019) | Download Citation

✓ New AI techniques for bio-detection in the visible range

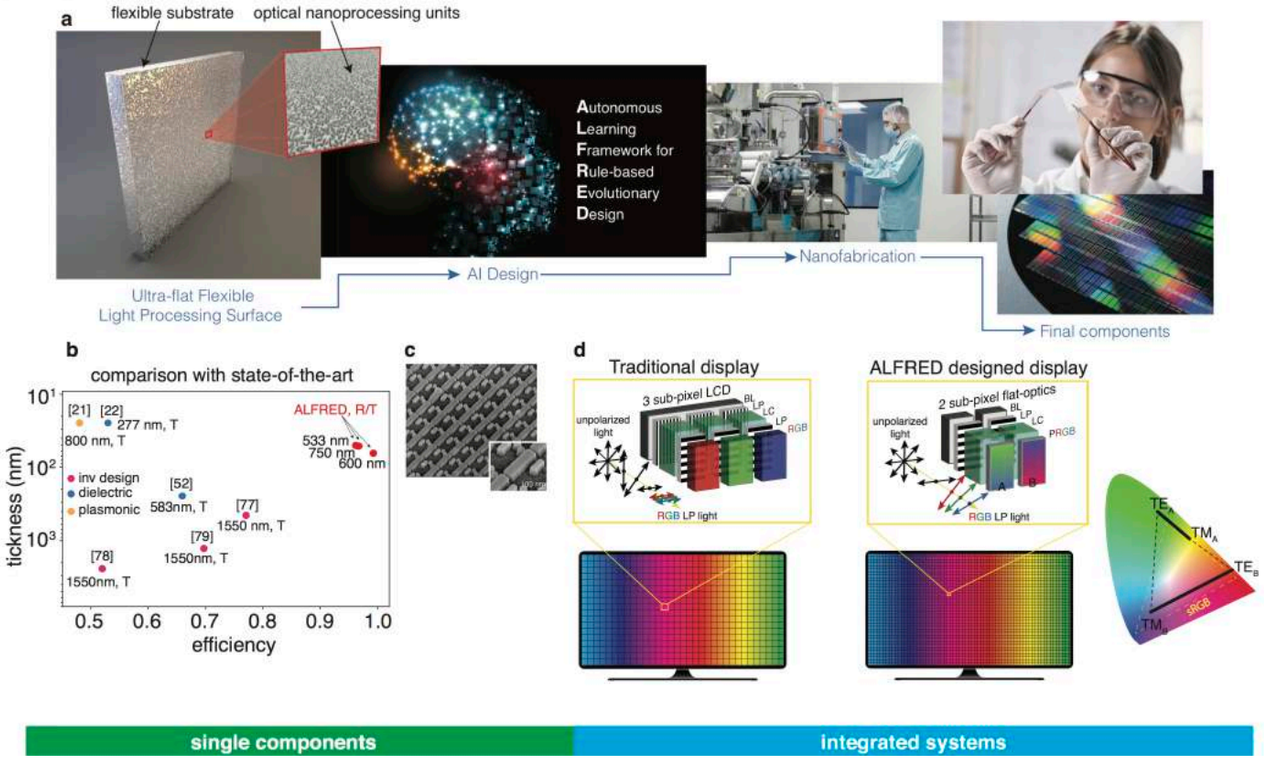




Applications

AI: Autonomous Learning Framework for Rule-based Evolutionary Design (ALFRED)

✓ Proprietary Patented revolutionary technology for high-efficient, ultra-thin (50 nm), dense optical nanoprocessing metasurfaces (KAUST 100% owned Patent)



- Single and flexible optical components at 1/10 the current commercial cost
- New Integrated systems (displays, cameras,…) with custom designed properties that can be arbitrarily defined and engineered by the user
- Custom made AI learing algorithms capable of running on supercomputers and HPC clusters.

- US Patent App. No. 62/799,324

Industrial Collaborations
Overview

➢ ***Energy Harvesting:***

- Foundacion Avina (Switzerland/Latin America), PERA Complexity (Sweden), University of Zurich (Switzerland).

➢ ***Crypto Security***

- Tyndall (UK), CUP Science (US, LA, California), University of St. Andrews (UK).

➢ ***Photovoltaics***

- Ningbo Sibranch International Trading Co.,LTD. (China).