Institut des Nanotechnologies de Lyon (Romain BACHELET)

UMR-CNRS (INSIS): ~200 people (~120 permanent) Dir.: B. Masenelli

ICT

Energy

Health

UNIVERSITÉ DE LYON

ÉCOLE CENTRALE LYON

INSA

Lyon 1

CPE LYON

N A M e

GDR Nanomaterials for Energy Applications

ELABORATION
MEASUREMENTS & METROLOGY
SIMULATIONS & THEORY
APPLICATIONS

inl

Institut des Nanotechnologies de Lyon UMR 5270

https://inl.cnrs.fr/

cnrs

Research teams (& people) involved in the GDR NAME (> 18 permanent)

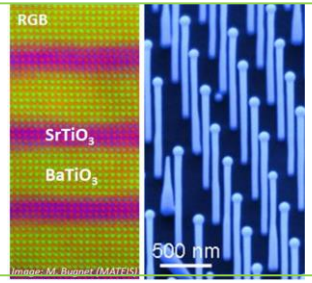
nanolyon

Functional Materials & Nanostructures (>9 p)

Co-Heads: R. Bachelet & N. Chauvin

Participants: ***R. Bachelet***, *J. Penuelas, B. Vilquin, G. Saint-Girons, P. Regreny, J.M. Bluet, N. Chauvin, B. Masenelli, A. Apostoluk*

https://inl.cnrs.fr/en/equipe-materiaux/



Light Engineering & Conversion (>7 p)

Head: C. Seassal / Dep.: A. Fave & C. Jamois

Participants: ***M.Amara***, *C. Seassal, E. Drouard, A. Belarouci, X. Letartre, T. Benyattou, H.S. Nguyen*

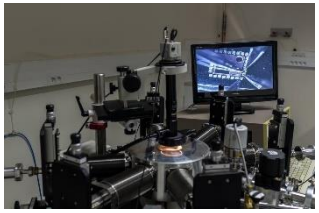
https://inl.cnrs.fr/en/ingenierie-et-conversion-de-lumiere-i-lum/

Electronic Devices (>2 p)

Head: D. Deleruyelle

Participants: ***N. Baboux***, *I. Canero-Infante*

https://inl.cnrs.fr/en/electronic-devices/



AXE
Élaboration
Mesures de propriétés
Mesures de performances de dispositif
Simulations/Théorie

Main materials:

- (Semi)conductors
- Di/Ferro-electrics

Functional oxides, III-V, IV (Si, Ge), ABX_3, P(VDF-TrFE),…

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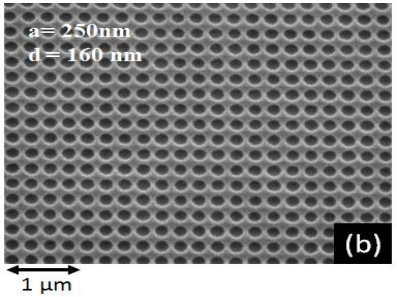
NAME
GDR Nanomaterials for Energy Applications

Renewable energy from light

Photovoltaic - Enhanced conversion by nanostructuration (light trapping) & multijonctions

Photonic-based PV enhancement / wavelength conversion
e.g. Photonic crystals (c-Si): +45% (18 mA/cm^2)
Projects: EU PhotonNVoltaics, ANRs,…
Collab.: IMEC, LPICM, Obducat, ILM,…

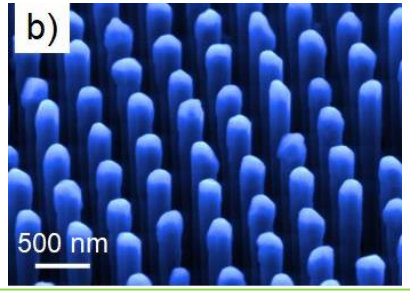


(**from >10y**)

C. Trompoukis et al. PSS (2014)

Haong et al., ACS Photonics (2017)

Nanowires-based PV
e.g. GaAs/ AlGaAs III-V nanowires
by MBE (VLS) for tandem solar cells
Projects: ANR HETONAN, EU Empir NWs
Collab.: C2N, IMEP-LAHC



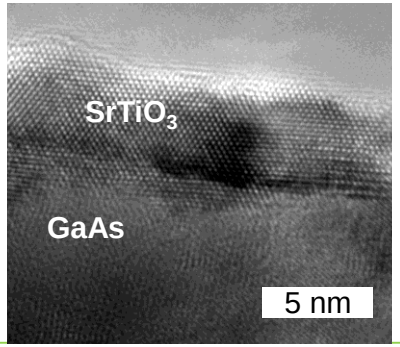
(**2013**-2023)

M. Vettori et al., Nanotech. (2017)
V. Piazza et al., Nanoscale (2018)

Photoelectrochemical: water splitting
Green hydrogen

Oxide/III-V core/shell nanowires &
Photonic crystals

Projects: ANR BEEP, IDEX IPPON,…
Collabs.: CEA, MATEIS, ICJ,…



(**2017**-2022)

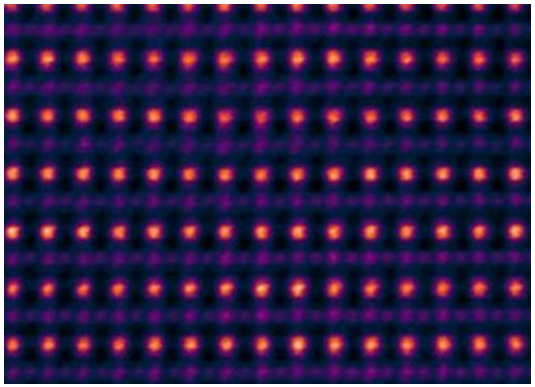
X. Guan et al., Nano Letters (2016)
X. Guan et al., Nanoscale (2016)
T. Dursap et al., Nanotechnol. (2021)

Thermal energy harvesting and cooling

Thermoelectric

Heavily doped perovskite oxide films by MBE

***N*-type** La-doped $SrTiO_3$ (PF ~ 40 µW.cm^{-1}K^{-2})
***P*-type** Sr-doped $LaCrO_3$ (PF ~ 1 µW.cm^{-1}K^{-2})



(**2015**-2022)

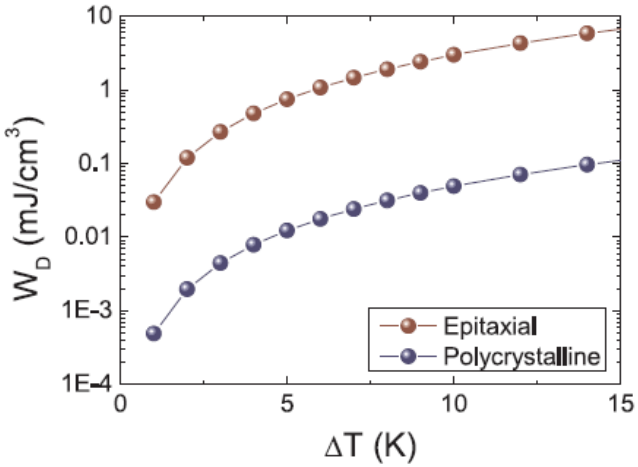
M. Apreutesei et al., STAM (2017)
D. Han et al., JAP (2019)
D. Han et al., ACS AEM (revision)

Projects: H2020 TIPS, ANR MITO, CSC, MITI-CNRS,…
Collab.: ILM, CETHIL, ICMAB, MATEIS, LOMA,…

Pyroelectric & electrocaloric

Ferroelectric oxide films
Enhanced conversion by epitaxy
e.g. $Pb(Zr_{1-x}Ti_x)O_3$ (**PZT**) films by CSD

Harvesting: W_D ~1 mJ/cm^3 (with ΔT = 10°C)
Cooling: ΔT = 10°C (with E = 500 kV/cm)



(**2013**-present)

R. Moalla et al., CrystEngCom (2016)
R. Moalla et al., Nano Energy (2017)
R. Moalla et al., Sci. Rep. (2018)

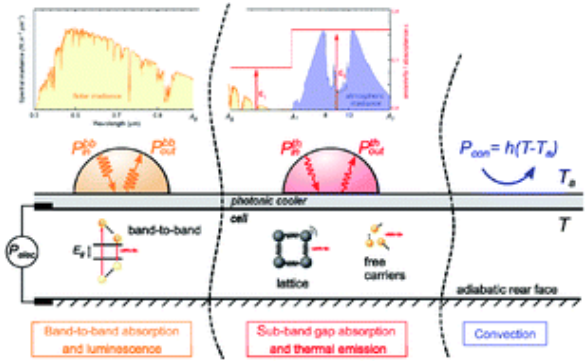
Projects: ADR region, CNRS-Energie
Collab.: LGEF, CEA LETI

Thermal management

Radiative cooling

For PV cells
Efficiency enhancement by cooling

Project: PhD thesis J. Dumoulin



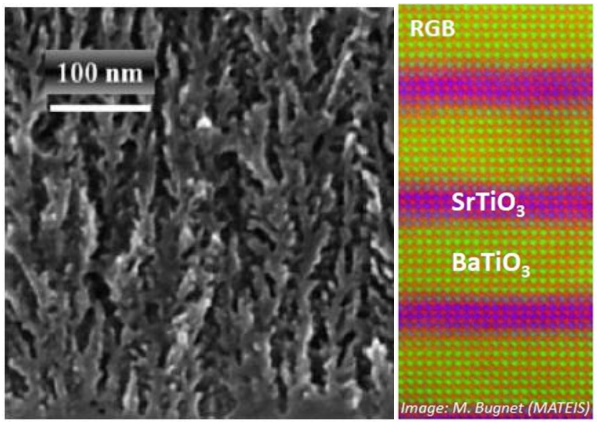
(**2019**-2022)

J. Dumoulin *et al*., Sust. En. & Fuels (2021)

Lowering thermal conductivity
by nanostructuration & "alloying"

e.g.
Nanoporous Si and SiC by electrochemistry
Si membrane and phononic X[al]
Short-period superlattices

Projects: PhD thesis A.M. Massoud, ANR MITO,…
Collab.: CETHIL, IEMN, LOMA,…



(**2012**-present)

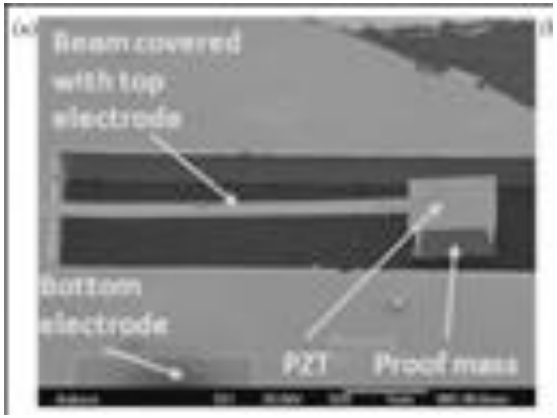
A.M. Massoud *et al*., JAP (2020)

Mechanical energy harvesting

Piezoelectric

Enhanced by epitaxy & integrated on Si
$Pb(Zr_{1-x}Ti_x)O_3$ (**PZT**) epitaxial films
by CSD, sputtering

Project: ANR Piezo2power
Collab.: LGEF, CEA LETI



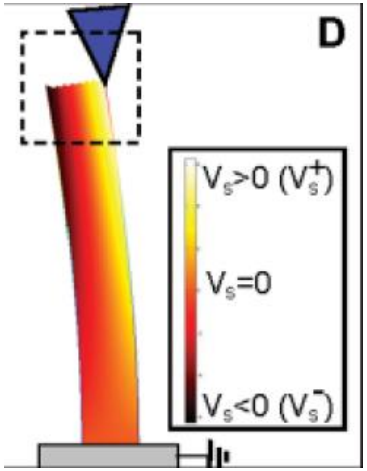
(**2011**-2014)

S. Yin *et al.*, TSF (2012)
Y. Shi *et al.*, JAP (2014)

Piezophototronic

Core/shell III-V/oxide nanowires
by MBE/other

Collab.: LTM, IMEP-LAHC



(**2012**-2015)

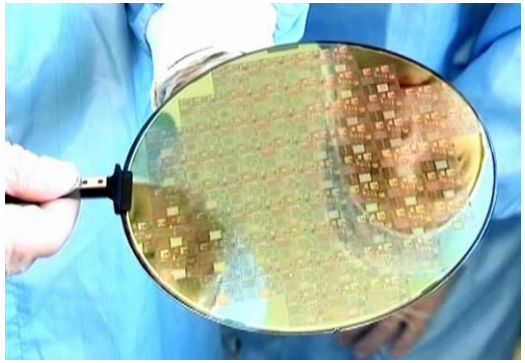
X. Guan *et al.*, Nano Letters (2016)
X. Guan *et al.*, Nanoscale (2016)

Technological clean room facilities: Nanolyon platform

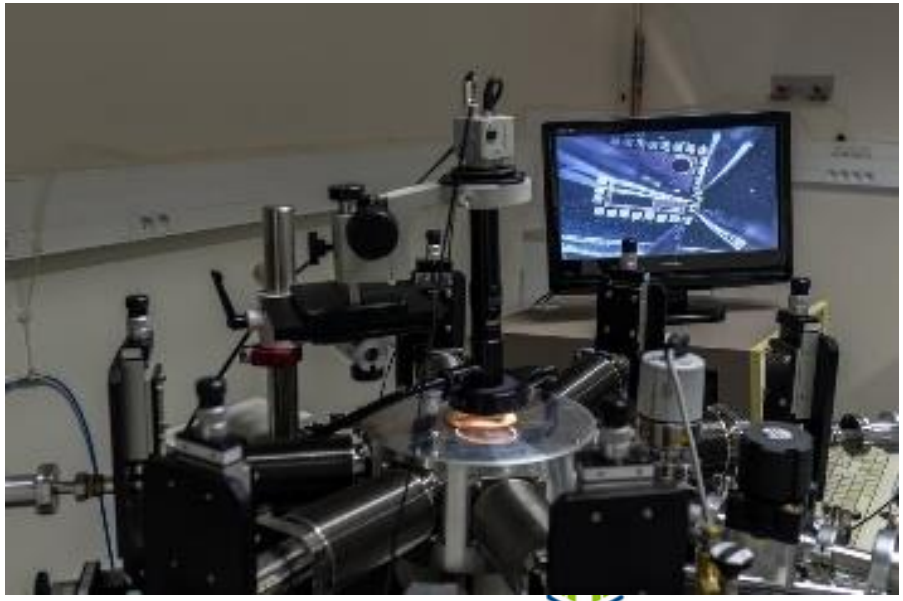
Elaboration (epitaxial III-V, oxides)

UHV cluster: MBE (III-V + oxides) + sputtering + XPS (+ ALD)

Microfabrication



Characterizations (structural & physical)



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Technological facilities: Nanolyon platform

Elaboration

MBE (III-V & oxides), Sputtering, ALD, CSD, PECVD

Microfabrication

RIE-ICP, e-beam, Nanoimprint, UV lithography,…

Structural characterizations

XRD(T), XPS-XPD(T), AFM, RHEED,…

Physical characterizations

(Thermo)Electrical & optical characterizations: ferroelectric, pyroelectric, thermoelectric, ellipsometry, PL, CL, Raman,…

Interests in collaborations

- **Thermal conductivity** measurements in films and nanowires
- **Low temperature** (electronic) **transport** (PPMS)
- **Thermoelectric** characterizations (Seebeck) in films over a **wide temperature range**
- **Theoretical**: calculation/prediction of properties

Contact

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