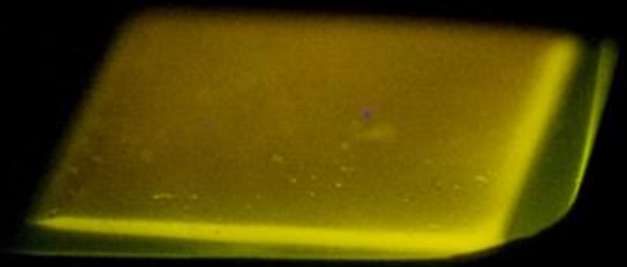
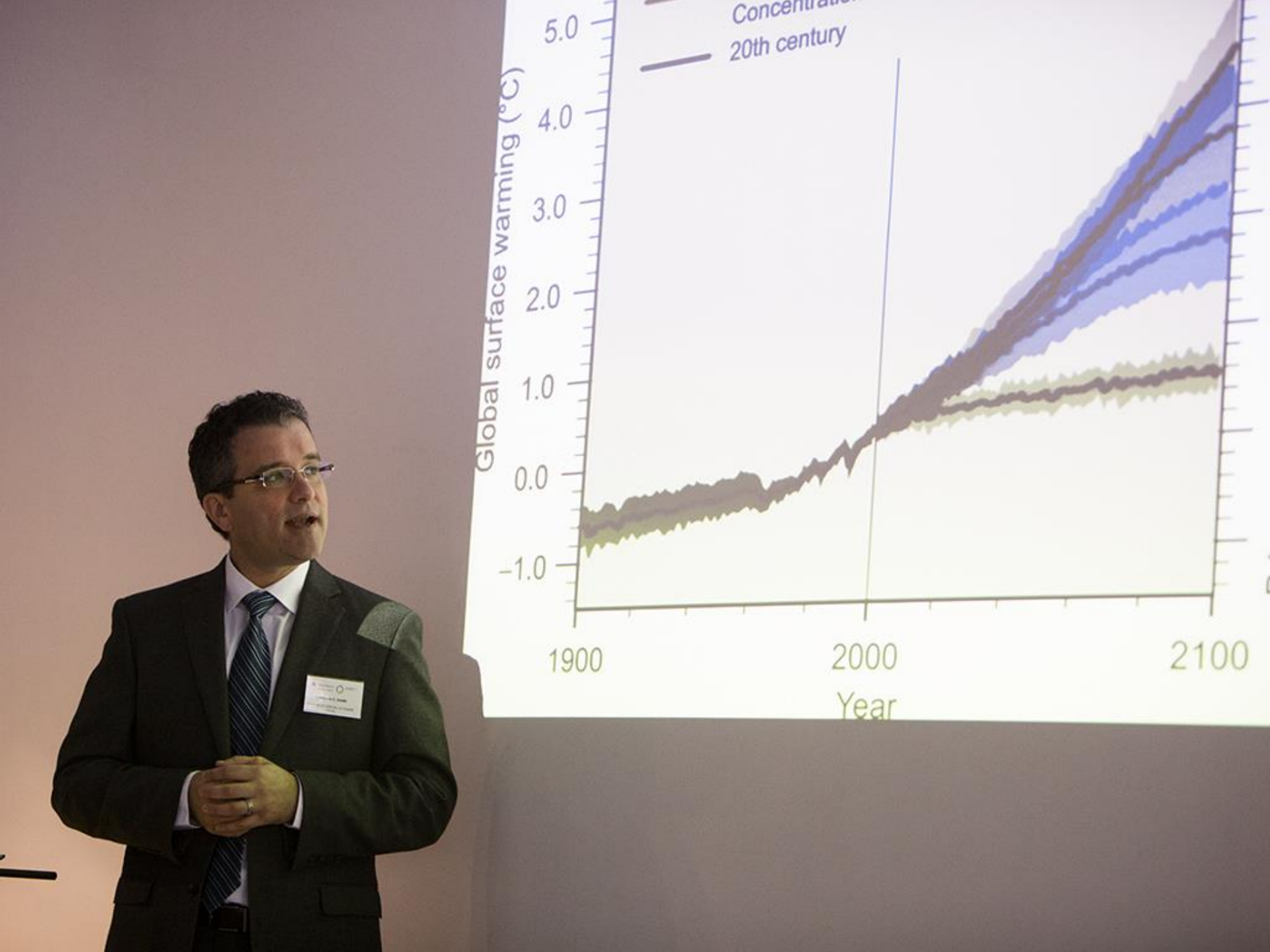
Mikael Syväjärvi

NORLED : N-Inner (ii) project

Nordic Light Emitting Diode Initiative

Fluorescent silicon carbide for white LEDs

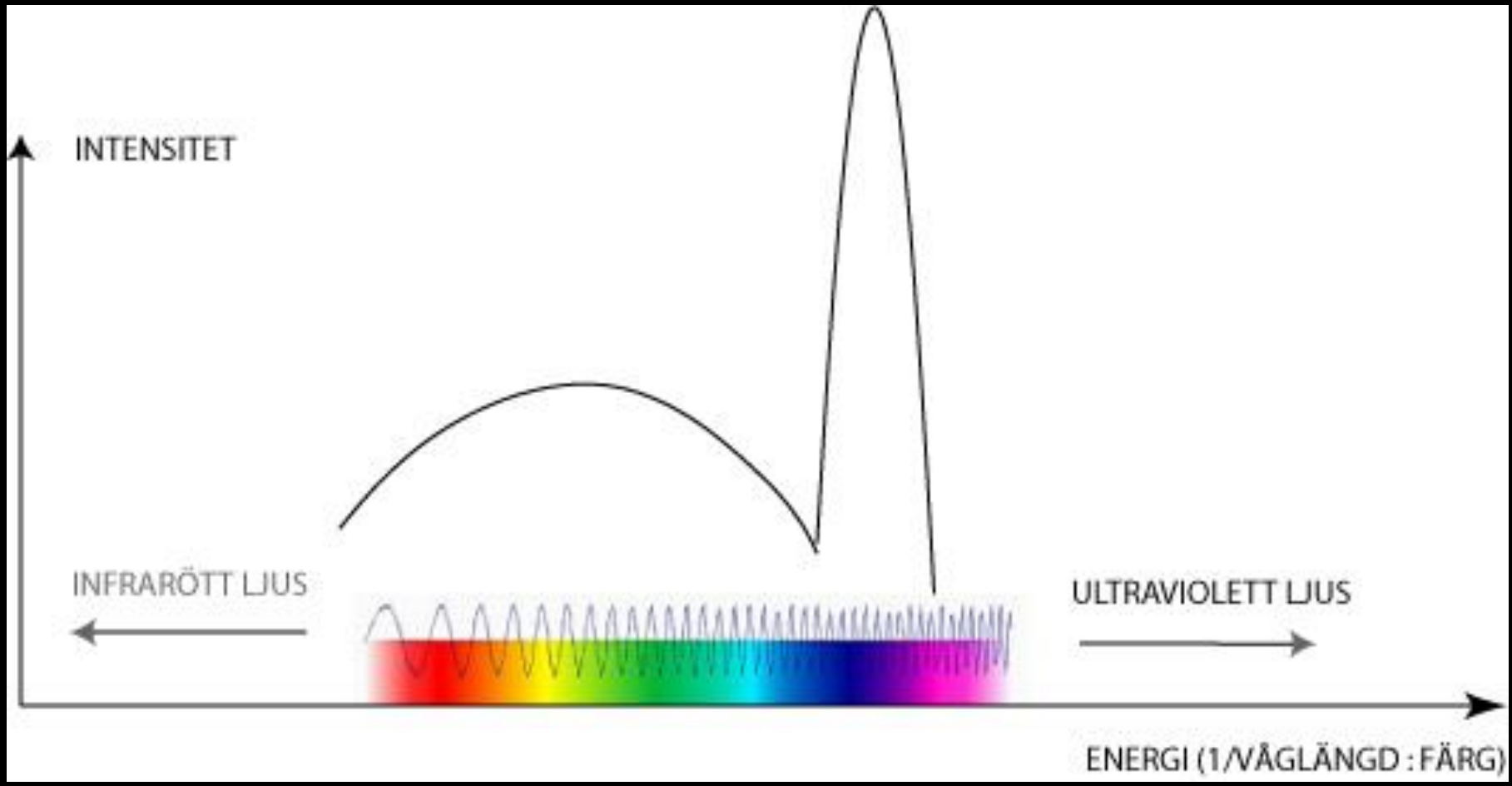



Concentrations
20th century
Global surface warming (°C)
5.0
4.0
3.0
2.0
1.0
0.0
−1.0
1900
2000
2100
Year


European Economic and Social Committee
www.eesc.europa.eu

white LEDs

Phosphor conversion

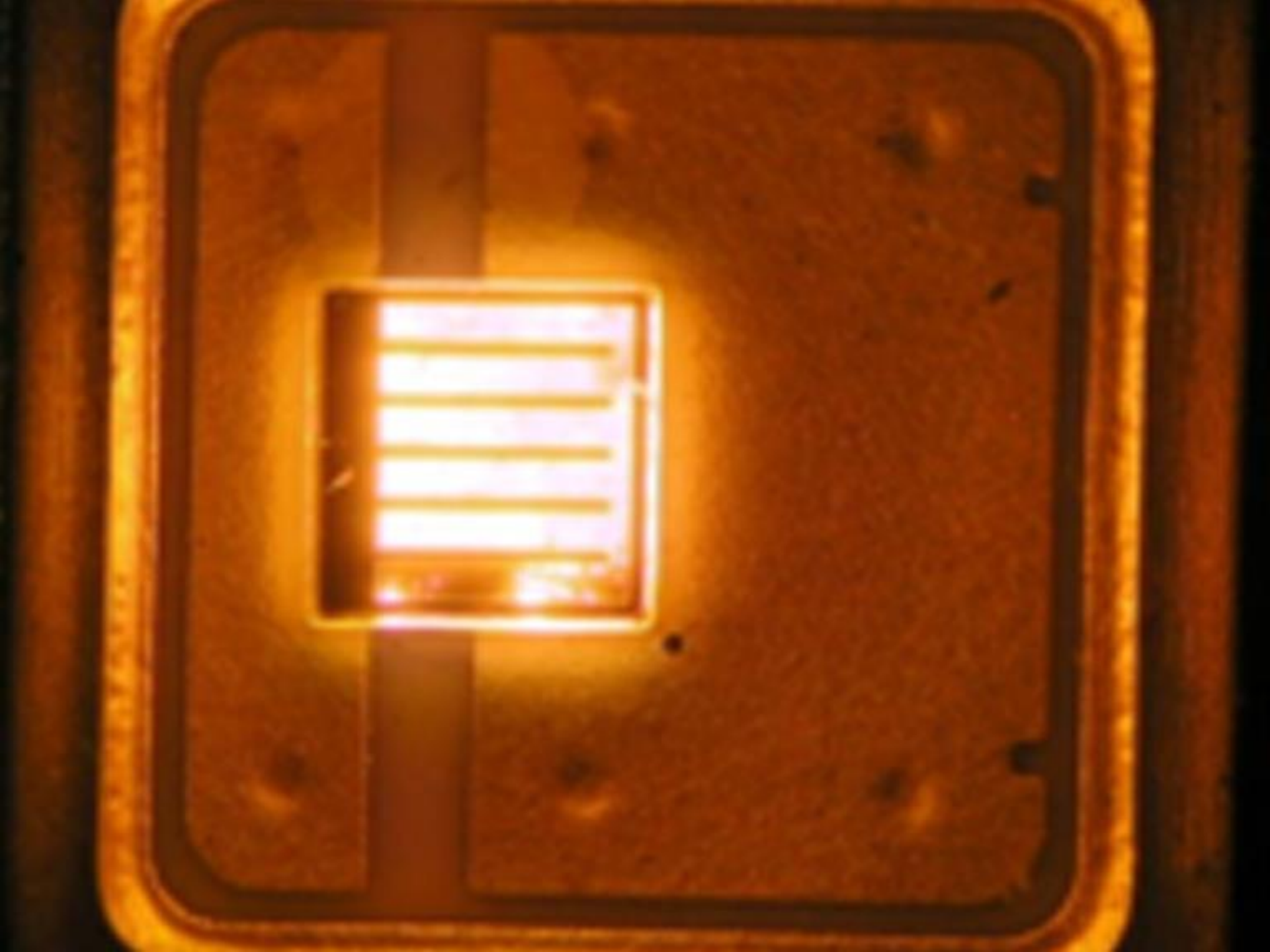


BLUE TONE

BINNING

DROOP


NORILSK



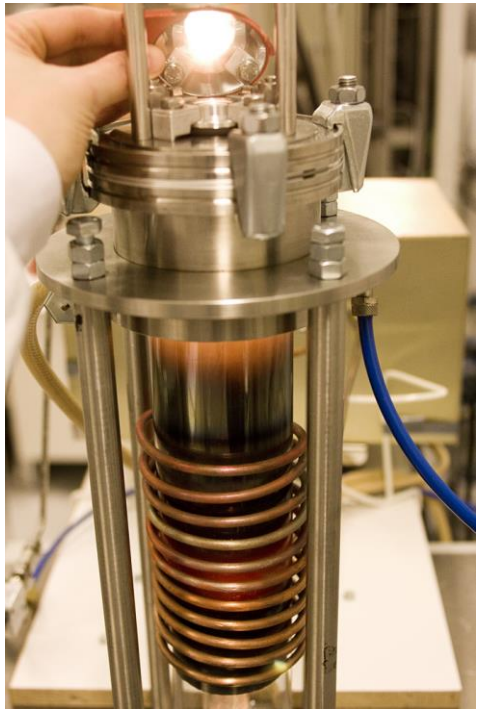
COMPREHENSIVE SEMICONDUCTOR SCIENCE AND TECHNOLOGY

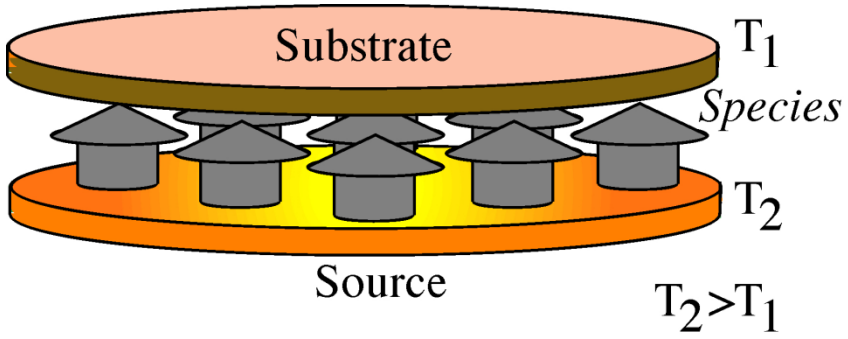
3.05 Sublimation Epitaxial Growth of Hexagonal and Cubic SiC

M Syväjärvi and R Yakimova, Linköping University, Linköping, Sweden

Volume 1

Editors
Pallab Bhattacharya
Roberto Fornari
Hiroshi Kamimura





1907

A Note on Carborundum.

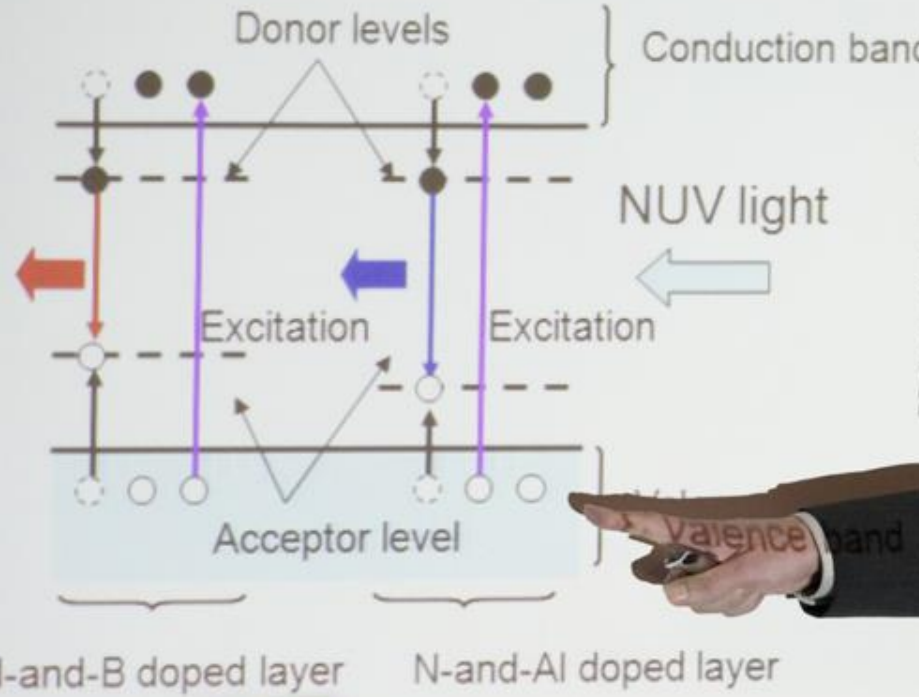
To the Editors of Electrical World:

SIRS:—During an investigation of the unsymmetrical passage of current through a contact of carborundum and other substances a curious phenomenon was noted. On applying a potential of 10 volts between two points on a crystal of carborundum, the crystal gave out a yellowish light. Only one or two specimens could be found which gave a bright glow on such a low voltage, but with 110 volts a large number could be found to glow. In some crystals only edges gave the light and others gave instead of a yellow light green, orange or blue. In all cases tested the glow appears to come from the negative pole, a bright blue-green spark appearing at the positive pole. In a single crystal, if contact is made near the center with the negative pole, and the positive pole is put in contact at any other place, only one section of the crystal will glow and that the same section wherever the positive pole is placed.

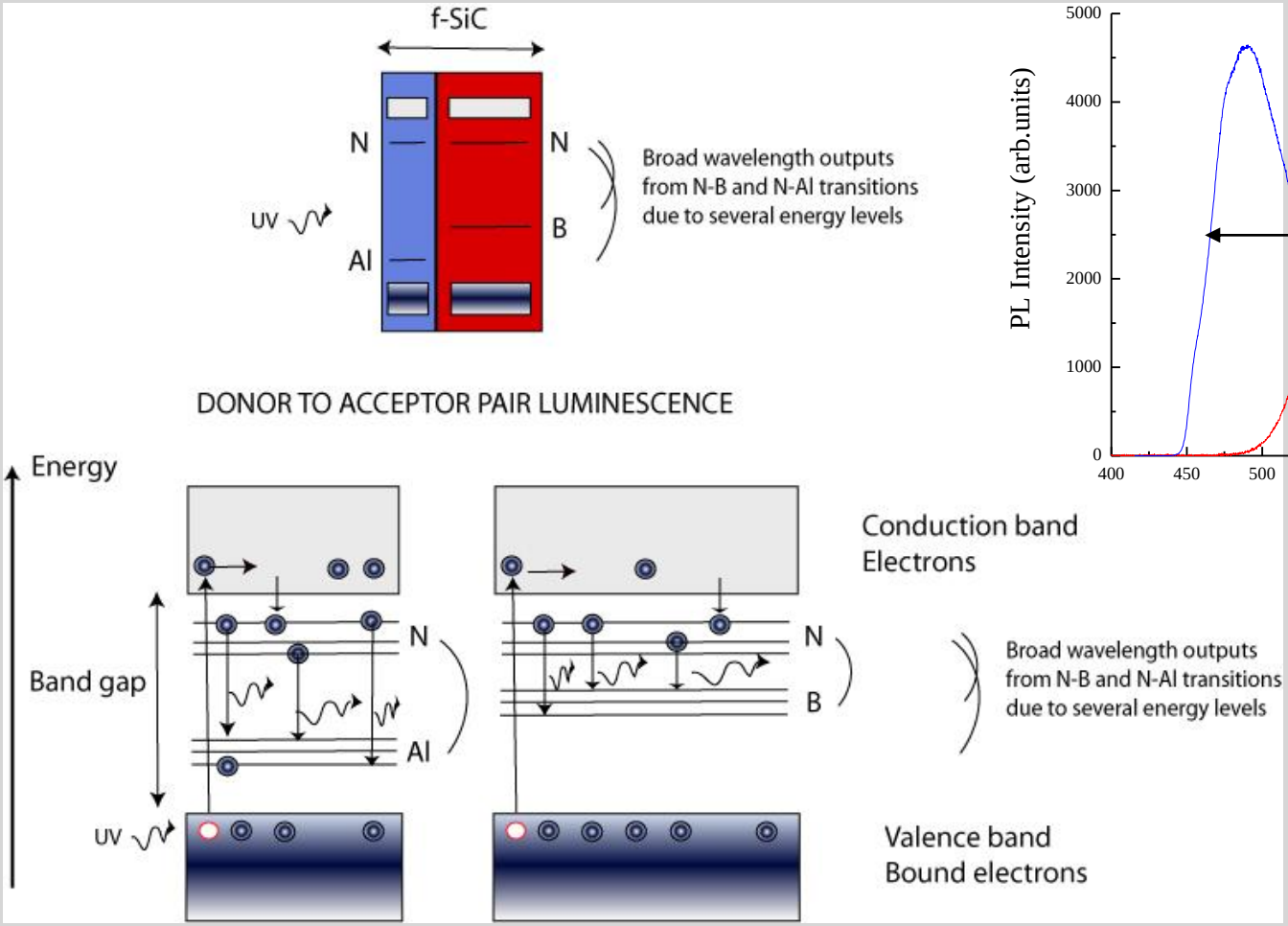
There seems to be some connection between the above effect and the e.m.f. produced by a junction of carborundum and another conductor when heated by a direct or alternating current; but the connection may be only secondary as an obvious explanation of the e.m.f. effect is the thermoelectric one. The writer would be glad of references to any published account of an investigation of this or any allied phenomena.

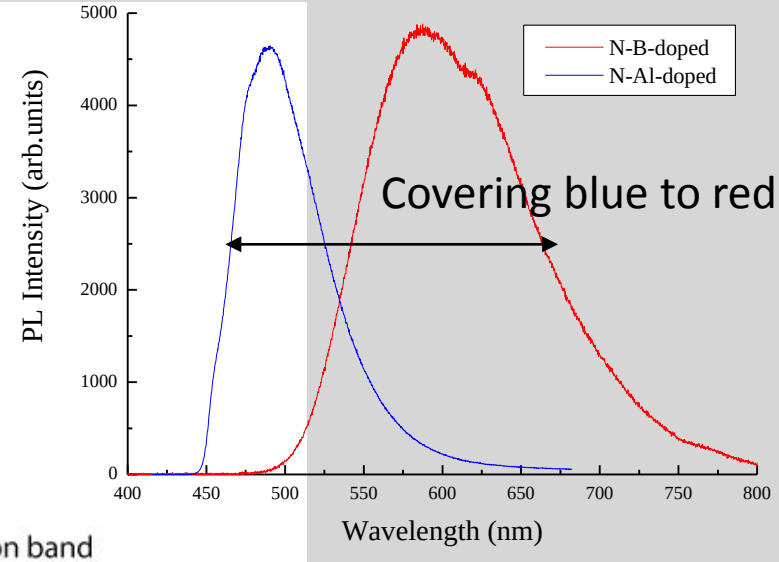
NEW YORK, N. Y. H. J. ROUND.

White light generation using DAP recombination in SiC

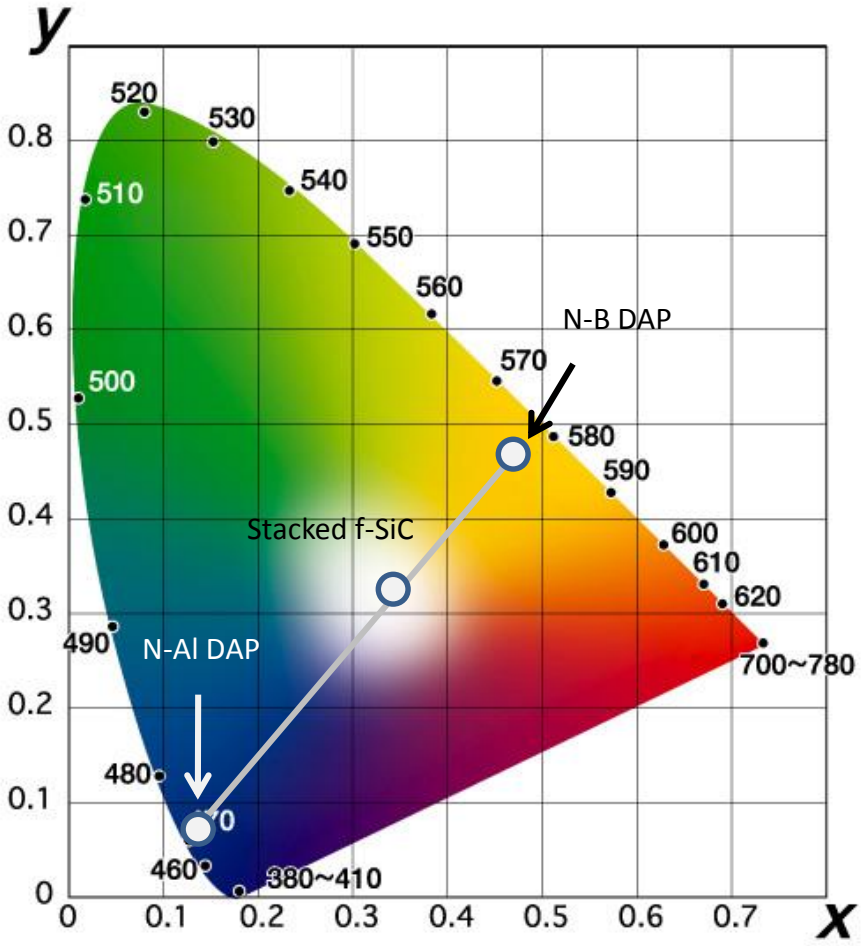


White light generation using silicon carbide



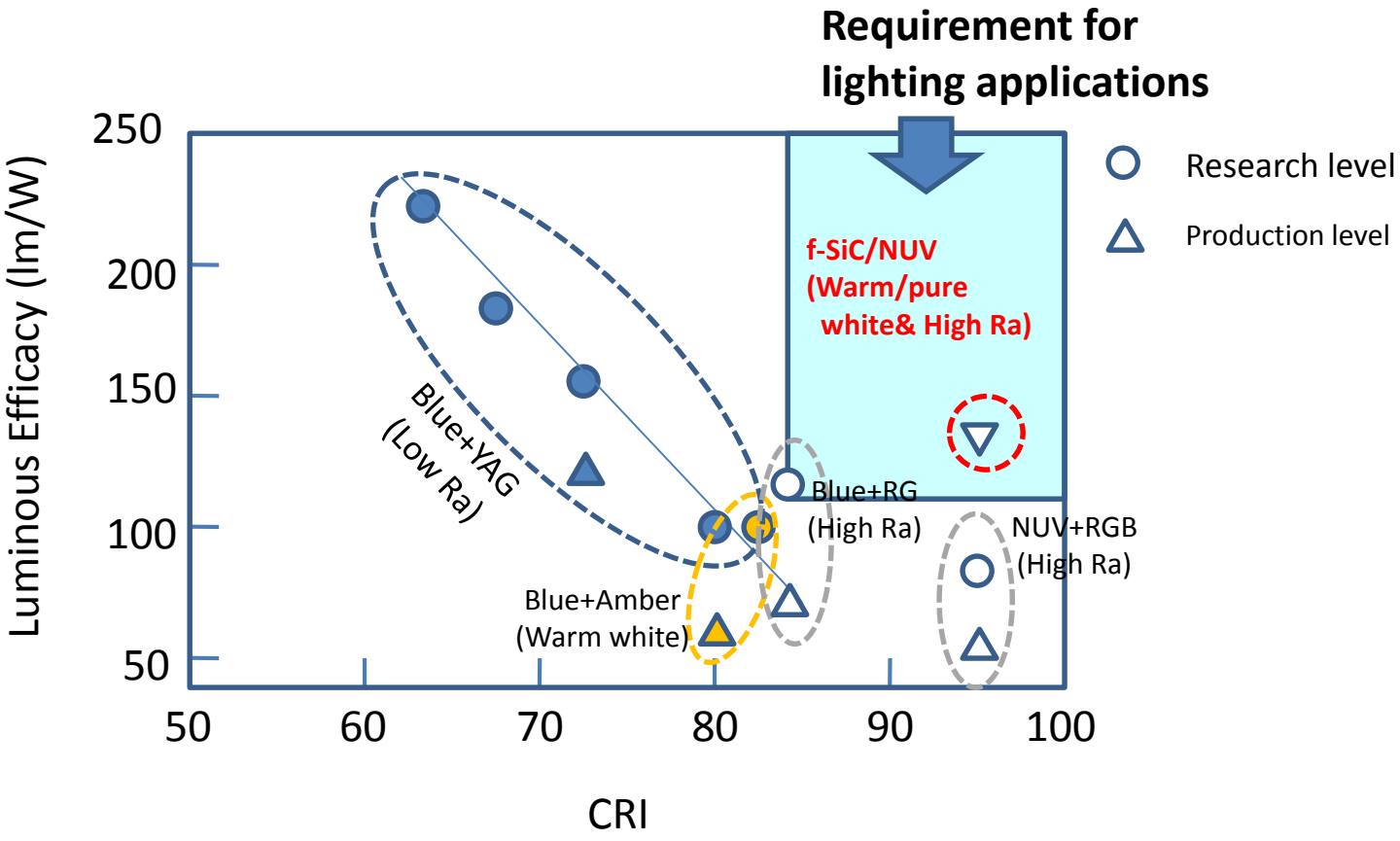


CIE Chromaticity Coordinates



N-B DAP:
x=0.486, y=0.465
N-Al DAP:
x=0.137, y=0.085

Relationship between Luminous Efficacy and CRI



Nordic Energy

Northern European Innovative Energy Research Programme

N-INNER

The Swedish Energy Agency

Danish Council for Strategic Research

Projektträger Jülich in Germany

Research Council of Norway

Ångpanneföreningen Research Foundation

Richerts Foundation

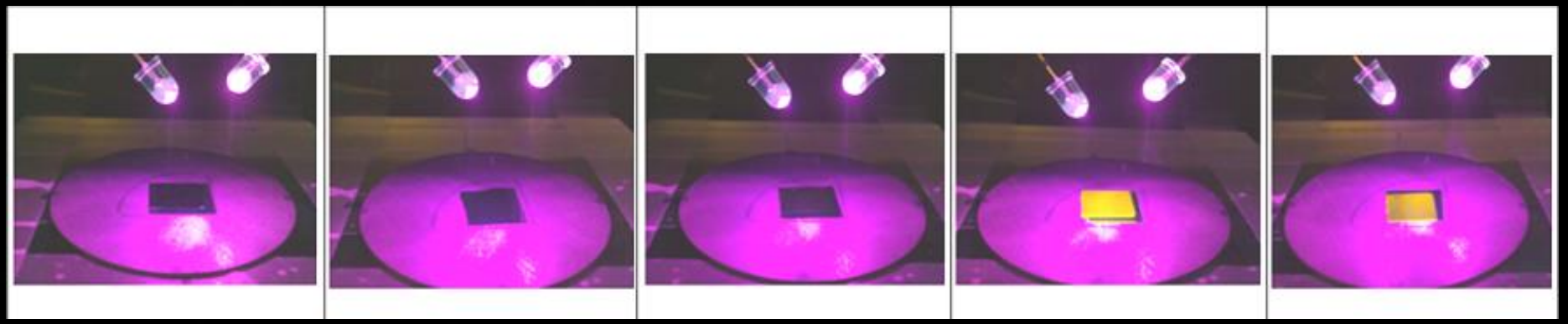
Swedish Research Council

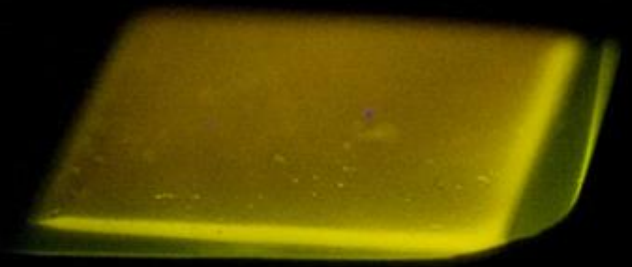
Bundesministerium für Bildung und Forschung

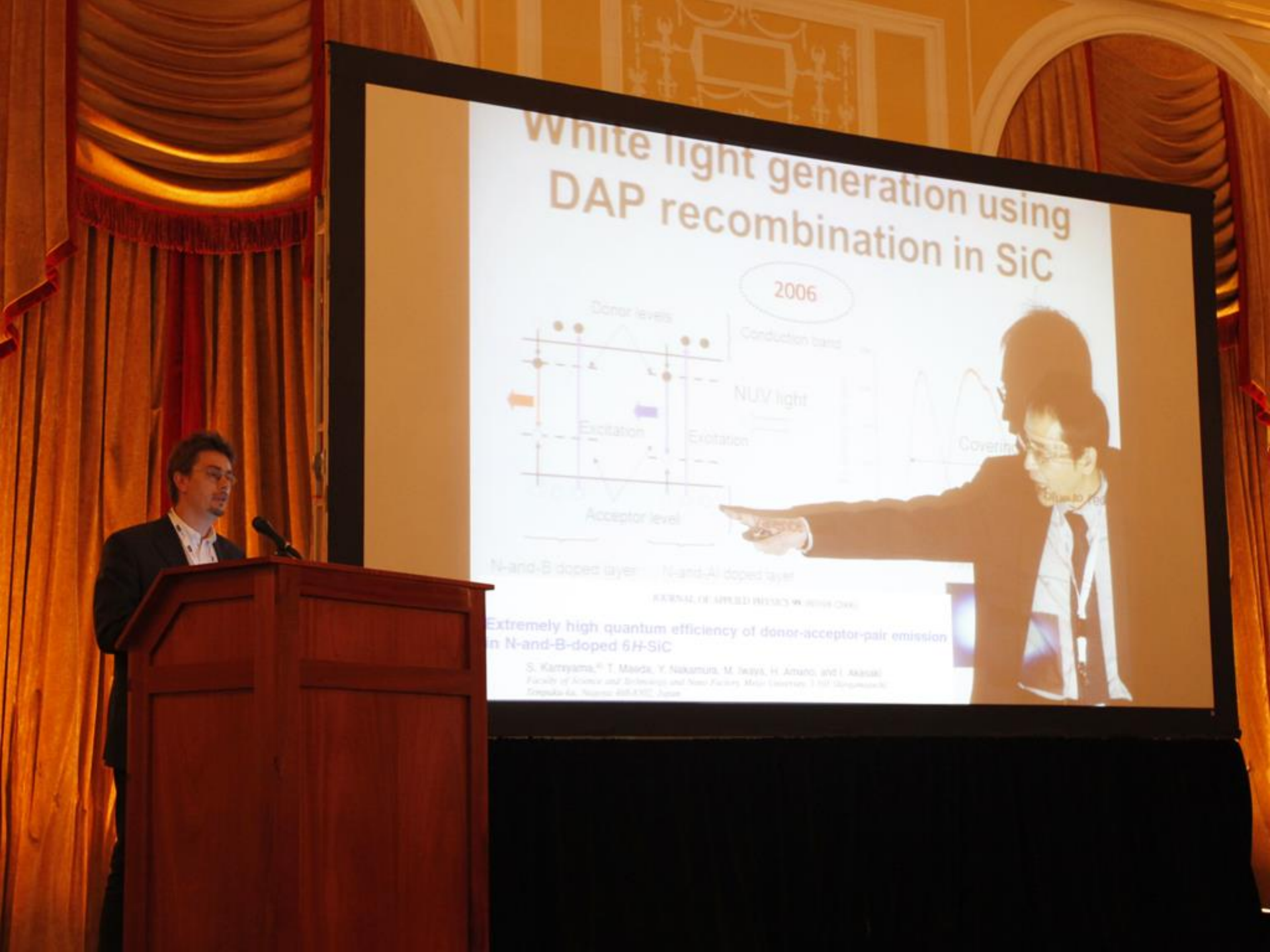
Danish council of research

Japan Society for the Promotion of Science

Department of the New Energy and Industrial Technology Development Organization (NEDO)






White light generation using
DAP recombination in SiC
2006
Donor levels
Conduction band
NUV light
Excitation
Acceptor level
N-and-B doped layer
Extremely high quantum efficiency of donor-acceptor-pair emission
in N-and-B-doped 6H-SiC

Letter to Editor Adv. Mat. Lett. 2012, 3(3), 175-176 ADVANCED MATERIALS Letters

www.vbripress.com, www.amlett.com, DOI: 10.5185/amlett.2012.7002 Published online by the VBRI Press in 2012

Perspectives of fluorescent and cubic silicon carbide

*i

sity, Department of Physics, Chemistry and Biology, Linköping 58131, Sweden

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2012 and Accepted: 03 June 2012

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2012 and Accepted: 03 June 2012

2010 – 2012/2013

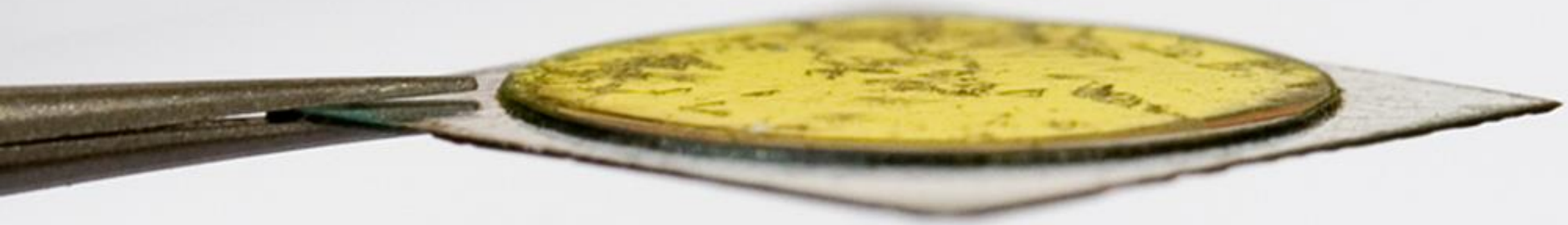
EL SEED

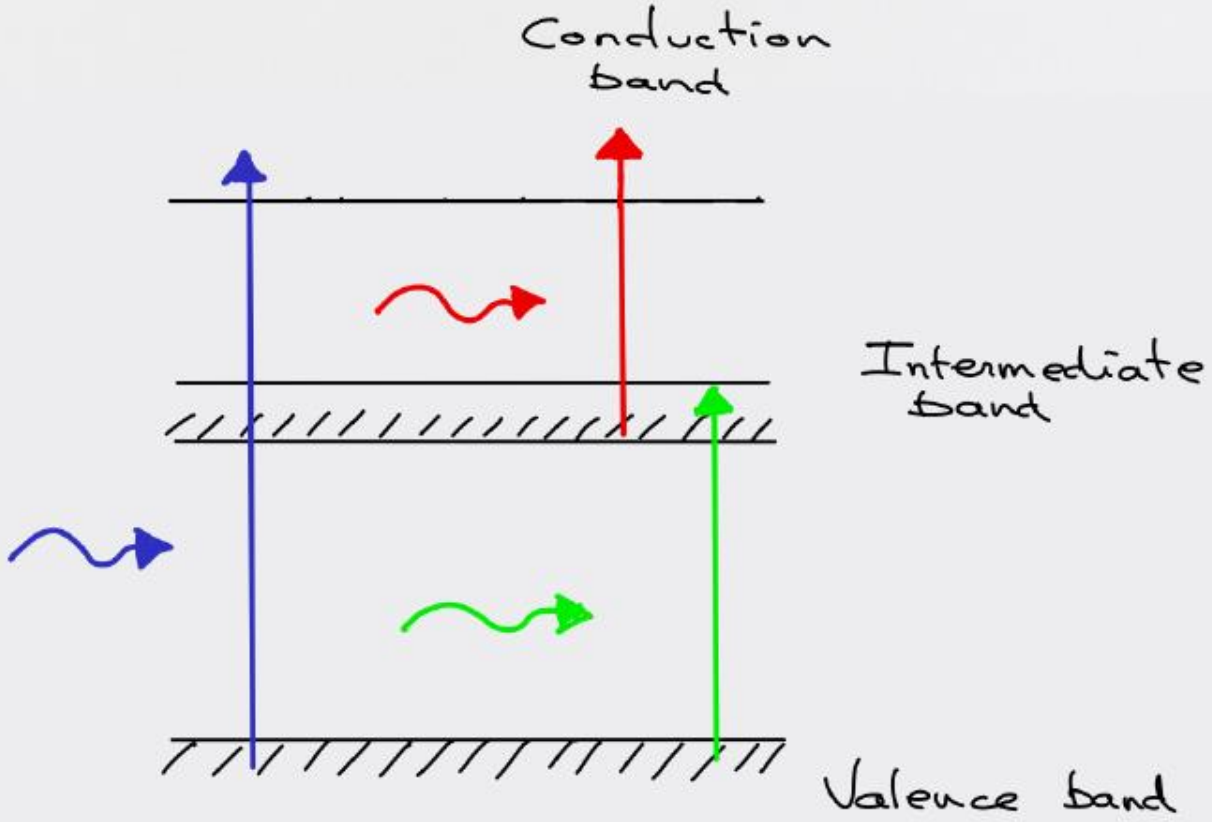
LIGHT EXTRACTION

NETWORK

what we gained

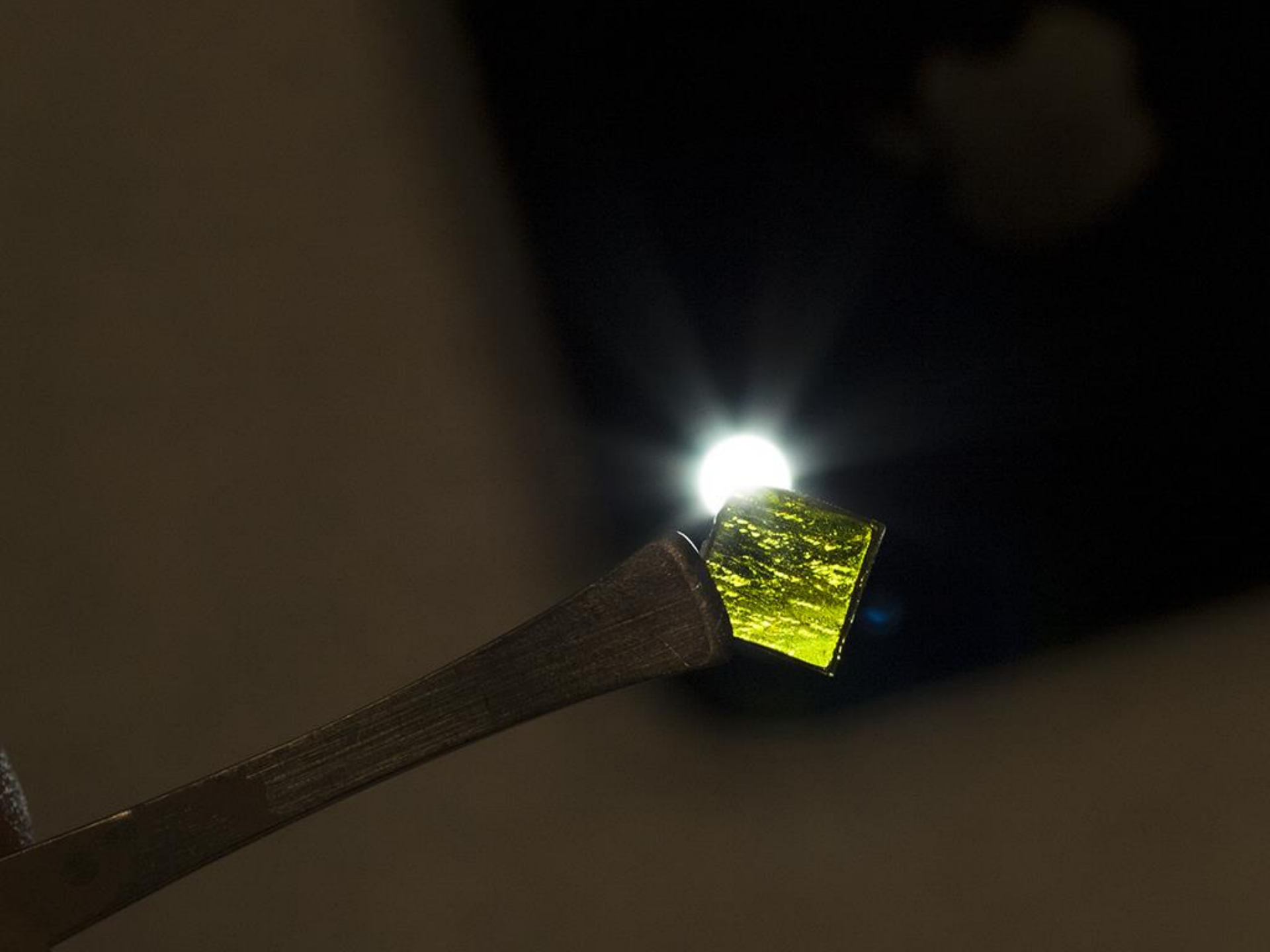
Another new idea: silicon carbide as solar cell material



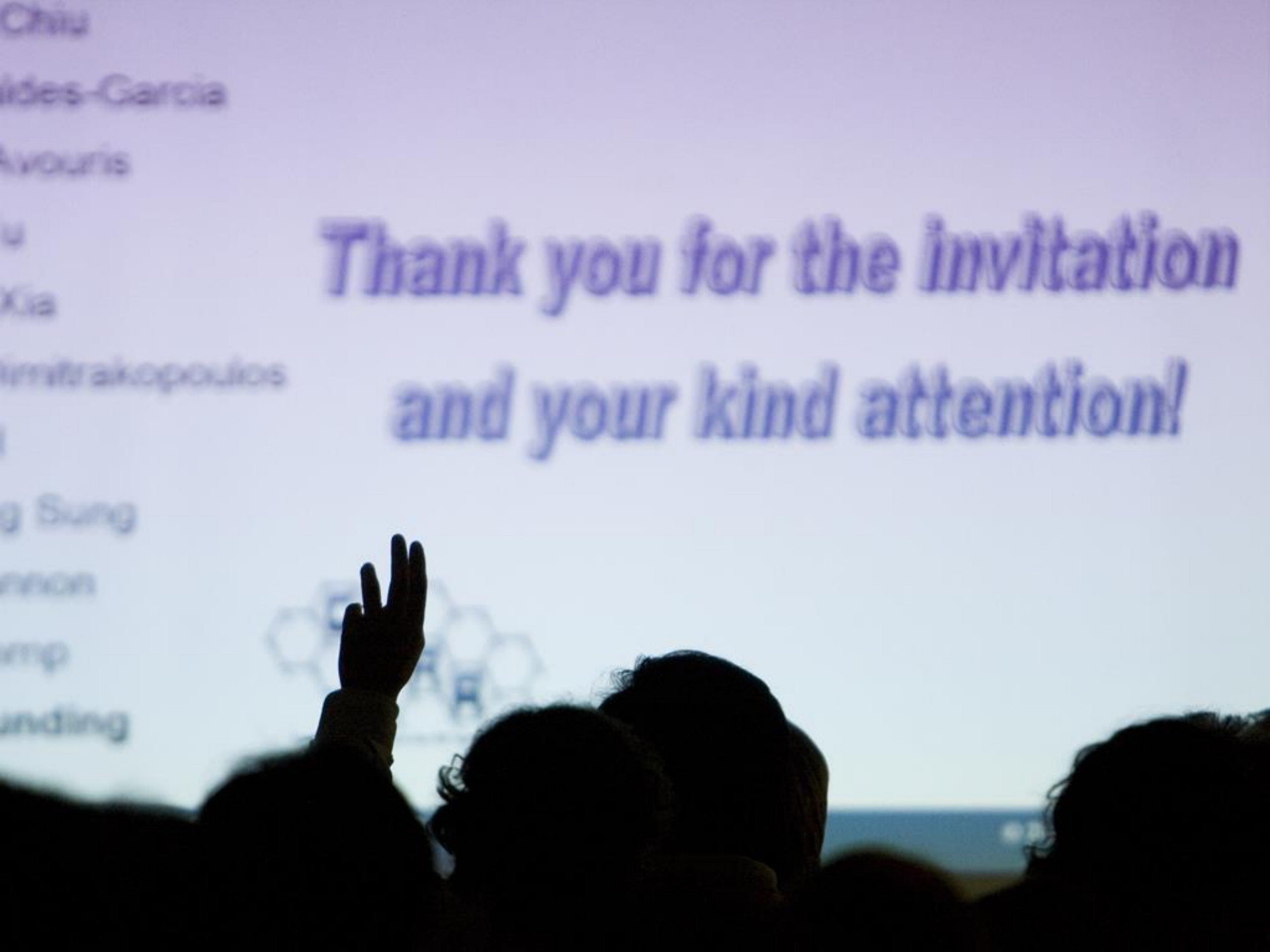


FULL Proposal for a new COST Action

TITLE: PHOTOVOLTAIC: NEW ALTERNATIVES AND INNOVATIVE MATERIALS




THANK YOU


Thank you for the invitation
and your kind attention!

Nordic research

NORLED

- Northern Light Emitting Diode Initiative
- 2010-2012

NORLED

The NORLED project develop an innovative and industrially feasible white LED technology for general lighting. The white LED structure is free of phosphor and has a highly efficient luminescence with a comfortable light quality to the human eye. The project consortium is composed of partners from Sweden, Denmark, Germany and Norway. Multidisciplinary (technical, social, economic) scientists are gathered together with representatives from the industry.

Project duration is Jan 1, 2010 - Dec 31, 2012.

NEWS

Jan 1, 2010 - NORLED project is officially started!

Northern Light Emitting diode initiative

N-Inner (ii) project

- Nordic Energy Research managing call
- 11 partners
- 4 countries
  - Sweden,
  - Germany
  - Denmark
  - Norway

SWEDEN:

Linköping University:

Dr. Mikael Syväjärvi, PhD student Valdas Jokubavicius (Material science crystal growth - FSGP development)
Dr. Mats Bladh (new lighting solutions and their social tendencies)
Dr. Mats Söderström (energy systems)

Jönköping University:

Prof. Nils Svendenius (room lighting design)

Royal Institute of Technology:

Dr. Margareta Linnarsson (material doping evaluation)

Optoga AB:

Dr. Marcus Björkman (LED armature)

Trans Atlantic Technology AB:

MSc Johan Ekman (industrial application and production technology)

NORWAY:

University of Oslo:

Dr. Harold Wilhite (environmental change and sustainable energy)

DENMARK:

Technical University of Denmark:

Dr. Haiyan Ou, new PhD student (LED and optical characterization)

GERMANY:

University of Erlangen:

Prof. Dr. Peter Wellman, PhD student MSc Michl Kaiser (fundamental SiC crystal growth and doping)
Prof. Dr. Erdmann Spiecker, one postdoc/PhD student (structural properties of doped crystals)

LYSSNA PÅ WEBBRADIO LYSSNA DIGITALT SÖK

P1 P2 P3 P4 NYHETER / EKOT RADIOSPORTEN KANALER PROGRAM & TABLÅER

Sveriges Radio P1 A-Ö DEBATT KULTUR LIVSÅSKÅDNING HATER & NOLLO NÖJE SAMHÄLLE VETENSKAP

VETENSKAPSRADION

med Vetenskapsnyheter, Vetandets värld, Vetenskaperadions veckomagasin

Måndag 16 februari 2009

Ny typ av lysdiod kan ersätta glödlampan

Snart släcks glödlampan snart för gott. Inom tre år ska lamporna vara borta från marknaden. Det har EU beslutat. Orsaken är att glödlamporna är ineffektiva och EU vill minska elanvändningen. På Linköpings universitet pågår just nu forskning kring en lysdiod som ska ersätta glödlampan.

Mikael Syväjärvi, Linköpings universitet

SENASTE SÄNDNINGEN

Vetenskapsnyheter

18-dagarsarkivet

Vetandets värld

Rositsa Yakimova och Mikael Syväjärvi vid Linköpings universitet har utvecklat ett nytt material för lysdioder. 46 miljoner ska sätta fart på projektet. Foto: Stefan Jerrevång

Tipsa
Skriv ut
Större text

Linköpingsljus lockar japaner

Av: Ulla Karlsson-Ottosson 10 kommentarer
Publicerad 12 maj 2010 00:00

Högeffektiva lysdioder som sprider ett varmt vitt ljus. Linköpingsforskare får nu draghjälp av Japan för att ta fram en bra ersättare till glödlampan.

Linköping. Publicerad kl 14:37, 14 feb 2009 Skriv ut

Nytt ljus bortom glödlampan

Teamet som Mikael Syväjärvi tillhör samarbetar med ett japanskt forskarlag. – Vi är i princip ensamma i världen om vårt sätt att ta fram kiselkarbid, säger han. Det borde innebär ett försprång för Linköping när den nya lysdioden så småningom kan börja närma sig serieproduktion, menar han.

Overview of project participants

SWEDEN:

Linköping University:

Dr. Mikael Syväjärvi (Material science crystal growth - FSGP development)
Dr. Mats Bladh (new lighting solutions and their social tendencies)
Dr. Mats Söderström (energy systems)

Jönköping University:

Prof. Nils Svendenius (room lighting design)

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GERMANY:

University of Erlangen:

Prof. Dr. Peter Wellman (fundamental SiC crystal growth and doping)
Prof. Dr. Erdmann Spiecker (structural properties of doped crystals)

11 partners
But mainly 4 active (with PhD students)

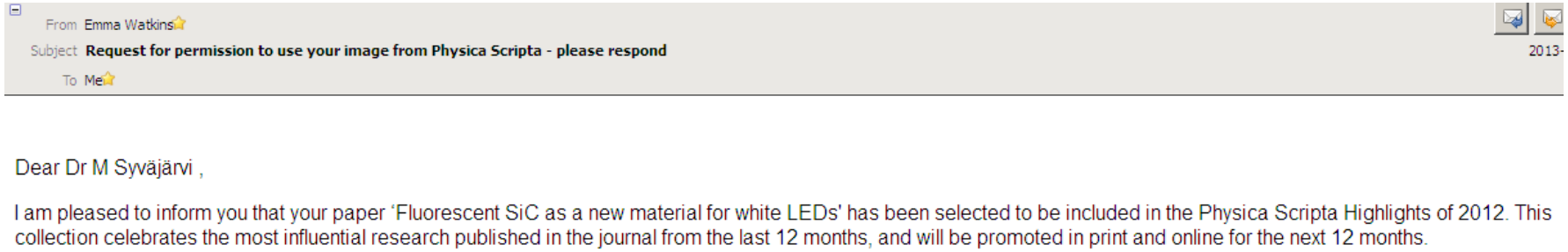
These 4 now continue network

Project budget, total and with an overview of external funding from other sources

- N-Inner (The Swedish Energy Agency, Danish Council for Strategic Research, Projektträger Jülich in Germany, Research Council of Norway) 700’000 EUR
- Swedish Research Council 2.4 MSEK
- Ångpanneföreningen Research Foundation 0.5 MSEK
- Vinnmer/Vinnova 2.4 MSEK
- NEDO (Japan) 5.6 MSEK
- Bundesministerium für Bildung und Forschung (Germany) 390.000 EUR
- Danish council of research 2.0 M DKK

Project progress and possible deviations

- Explore a new scientific field
  - Make light emitting material, study it
  - 3 invited talks at conferences
- Great progress
  - Two papers describing research area included in Physica Scripta Highlights of 2012



From Emma Watkins
Subject **Request for permission to use your image from Physica Scripta - please respond**
To Me

2013-

Dear Dr M Syväjärvi ,

I am pleased to inform you that your paper 'Fluorescent SiC as a new material for white LEDs' has been selected to be included in the Physica Scripta Highlights of 2012. This collection celebrates the most influential research published in the journal from the last 12 months, and will be promoted in print and online for the next 12 months.

Scientific findings and uniqueness of the project

- Demonstrated light emission from a new material and how physics can be understood
- Implemented growth methods and characterization methods to make and study the material

- Not explored by any other group world wide!

Networks, co-operations, seminars and mobility.

- **International cooperation**
  - Japanese project on LED (Meijo University)
    - Continues after NORLED
  - Vilnius University

- **Organized symposiums**
  - Energitinget 2010
  - E-MRS 2011
  - E-MRS 2013

- **Mobility**
  - By PhD students, postdocs, senior

Mobility / visits

- At LiU
  - ERLANGEN 2 weeks by PhD student, 6 months by 2 Erasmus diploma thesis student (joint thesis ERL and LiU)
- Several short visits LiU, Erlangen, DTU
- At Meijo
  - DTU, 3 month by PhD student, 3 months by senior
  - LiU, 2 weeks by postdoc
- At Vilnius University
  - Short visits

NORLED workshop

- Arranged Nov 2012

  PhD students and postdocs

  Michl Kaiser, Philip Hens, Valdas Jokubavicius, Ahmed Fadi, Daisuke Iida, Yiyu Ou, Jianwu Sun

  Lunch to lunch workshop

  Presentations of own topics and new ideas

Results: Phd degrees and academic publications

- Three PhD students
  - Thesis 2013-2014
  - 7xMaster theses, 6xBachelor theses

- Academic publications:
  - 2010 (1 conference, 1 journal)
  - 2011 (8 conference, 4 journal)
  - 2012 (15 conference, 14 journal)

Other publications / information activities (web, social media, television, daily press et cetera)

- Popular scientific presentations
  - Kungliga Ingenjörsvetenskapsakademien 100414 ”Smart belysning – hur bra kan lysdioder bli?”,
  - Fysikstudenter, Linköping 101027 ”Framtidens material –grafen och vita lysdioder”
  - Oslo University 110408 ”Development of phosphor free white LED for general lighting”
  - Länsstudiedagen, Linköping University 111013 ”Nobelpriset i fysik 2010 (grafen) och vita lysdioder

Media

Elektroniktidningen 100118, Ny Teknik 100118, Swedish Radio Vetenskapsnyheter 100118, Ny Teknik 100512, Ny Teknik 100823, Ny Teknik 101005, Östnytt Television 101008, Swedish Television Östergötland 110518, Norrköpings Tidningar 110518, Swedish Radio Östergötland 110519, Ny Teknik 110928, Östgöta Correspondenten 111001, Swedish Radio Vetenskapsnyheter 120306, Ny Teknik 120306, Elektroniktidningen 120306, Swedish Radio Vetandets Värld 120307, Semiconductor Today 120309, Compund Semiconductor 120319, Ny Teknik 120619, Semiconductor Today 120620, Elektroniktidningen 120628, Swedish Television Östergötland 120703

Research

Research is cancelled due to lack of funding

what did the n-inner call do for the initiation of collaboration, research area and network, how will it move forward?

- A great network

  N-Inner funding made collaboration and initial network possible
  - We had NOTHING before

  Network would have not existed without NORLED

  No new funding yet
  - Applied ITN (failed) and COST application (submitted) for collaboration

- New idea:
  - Photovoltaic silicon carbide research area