The Unlimited World of Applications for Nano & Photonics

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Avantes introduction

• Since 22 years Developer and manufacturer of compact spectrometers, light sources, fiber optics, Accessories

• 63 employees in Apeldoorn, 82 total worldwide

• Since 1994 more than 25,000 spectrometers sold

• Sales offices in US, China and the UK

• 44 Distributors all over the world
What is a spectrometer?
PhotonicsNL Association

1956: Nederlandse Vereniging voor Fotonica (NVvF)

2006: Foundation Photonics Cluster Netherlands (PCN)

2013: Association PhotonicsNL (PNL)

Vision:

Photonics: Key Enabling Technology for 21st Century (Societal Challenges)

Mission:

National Technology Platform for the Dutch Photonics Community and NL-portal to Europe and the US.

Stakeholders:

• Industry (SME’s and Internationals)
• Research Institutes, Universities and Engineering Academies
• Individual Members
Application areas

Photonics Research and Innovation Challenges

- Information & Communication (Integrated Photonics & Fibre Optics)
- Industrial Manufacturing & Quality (Laser Material Processing)
- Life Science & Health (Spectrometry & Spectral Imaging)
- Emerging Lighting, Electronics & Displays
- Security, Metrology & Sensors (Earth Monitoring & Fiber Optic Sensing)
- Design and Manufacturing of Optical Components (Integrated Photonics)
- Education, Training & Disruptive Research

Photonics as KET in Dutch Topsectors:

- High Tech Systems & Materials (Photonics as KET)
- Life Science & Health (Optical Diagnostics)
- Agriculture & Food (Spectral Imaging)
- Horticulture (Emerging Lighting & Spectral Imaging)
- Energy (Solar Cells & Emerging Lighting)
- Chemistry (Microscopy, Integrated Photonics & Micro Fluidics)
- Water (Micro Fluidics, Fiber Optic Sensing)

Putting light to work
TKI Chemie

• Council Nanotechnology & Devices
• Roadmap themes
  – Quality of Life
    • Bio-active sensing
    • Human disease models and Organ on a chip
    • Microfluidic devices for synthesis (medicine and food)
  – Cradle to cradle 2.0
    • Photochemistry
    • Micro flow reactors, speed up process development
    • In-line monitoring of processes
  – Energy efficiency and storage
    • New devices/materials for conversion of CO2 in Hydrocarbons
    • Nanostructures for efficiency improvement in energy conversion
Photonics - Nanotechnology

• **Photonics** is the science of light (photon) generation, detection, and *manipulation* through emission, transmission, modulation, signal processing, switching, amplification, and detection/sensing.

• **Nanotechnology** ("nanotech") is *manipulation* of matter on an atomic, molecular, and supramolecular scale.

• Synergy comes with the *manipulation*

• Both enabling technologies

• The scale is nanometers
Photonics markets
Markets & Application fields

- Green Energy & Environment
- Industrial processes
- Agriculture & Food

**Life Sciences & Health**
- Medical diagnostics
- Biomedical technology
- Pharma QA/QC
- Cosmetics
- Bioprocess monitoring
- Protein/DNA
- Single cell LIF
- Nanotechnology
- Food analysis
- Food sorting
- Freshness analysis
- UV disinfection

**Optical Diagnosis**
- spectroscopy & imaging
- UV-VIS
- IR
- Raman
- Fluorescence
- Greenhouse Lighting
- Livestock
- Horticulture meas.
- Precision Farming

**Clean Tech**
- Thin film control
- CIE Color Spectroscopy
- Plasma Monitoring
- Process control
- Soil / Water analysis
- Solid State Lighting appl.
- QA/QC, waste
- Gas / particle detection

**Scientific (Non-allocated)**

World of Applications for Nano & Photonics

12/04/2016 Avantes BV - Proprietary & Confidential -
Photonics in Life science

• Non-invasive real time monitoring system on hearth-lung machines
• SaO2, SvO2, Hb
Photonics in Agriculture

• The nitrogen sensor detects sunlight reflected by the crops

• Simultaneous measurement of sunlight
Photonics in Horticulture

Hortispec+
Combines Spectrometer & net radiation meter

Spectral information of incoming light

Integral value for:
Incoming light - Reflected light
Photonics Technologies for Fruit sorting

• Absorption of molecules
• Non-destructive fruit saccharinity grader
• For apple, pear, peach, tangerine, water melon
• Applied in 103 production circulation centers in Korea
Photonics Technologies for Food treatment

Quality control of food products resulting from heat treatments: cooking, roasting or frying

Measurement of compounds generated by Maillard reactions (reaction between sugars and/or fatty acids and proteins provoked by a heat treatment)

Formation of undesirable neoformed compounds such as acrylamide, furan
Photonics in Cleantec thin layer PV cell monitoring

- Reflection of Photons
- Thin layer solar cells to reduce cost
- In-line monitoring
- 10-channel spectrometer
Photonics Technologies for Cleantec

• LIBS technology for material analyses
• Manipulation of atoms
Continuous Emission Monitoring Systems (CEMS)

- Monitoring Air pollution in China
- Absorption of molecules
- DOAS Differential Optical Absorption Spectroscopy in UV
- 0.5 ppb i.e. 1.5mg/m3
- SO2, NO, NO2
Photonics in Nanotechnology

- Raman spectroscopy
- Manipulation of molecules
- Carbon nanotubes, graphene (extremely strong low weight)
- Provide structural information, stress, number of layers
Photonics for Public Safety and Security

- Manipulation of atoms and molecules
- Stand-off detection and identification of explosives at 20 meters
- Explosives detection (TNT, Chlorate, Cyclonite)

Spectra of RDX (blue, 1000 ms), HMX (pink, 1000 ms) and TNT (green, 500 ms).
Thank you for your attention