Danish Optical Society: Spectroscopy Day, September 30, 2011

Venue: HH Koch Aud. Risø DTU, Frederiksborgvej 399, Roskilde

ABSTRACTS

Spectroscopy for Dummies (invited)

Dr. Lars Lindvold, Radiation Research Division, Risø DTU

This presentation will give short introduction to the most pertinent topics of optical spectroscopy. The following topics will be discussed:

- The origin of spectra in UV, VIS and IR spectral range
- Spectroscopic methods like absorption, luminescence and Raman
- Wavelength dispersive optical components
- Materials for use optical spectroscopy
- Spectrometer geometries
- Detectors for use in spectrometer
- Practical examples of optical spectroscopy

The objective of this presentation is to give the audience a good feel for the range of possibilities that optical spectroscopy can provide.

Spectroscopy for demanding applications

Bjarke Rose, VP – Spectrometers, Ibsen Photonics A/S

With the technological development compact spectrometers have moved spectroscopy from laboratories to the field. In order to offer general-purpose platforms that can be modified to suit most every application a series of design compromises have been made, typically reducing the numerical aperture of the spectrometer and limiting the choice of detectors. For demanding applications lack of light prevents the use of low NA spectrometers, at the same time it is important to select the optimum detector.

In this presentation a high-throughput spectrometer platform is presented. The platform is based on fused silica transmission gratings that besides ultra-low thermal drift offer unmatched efficiency. Further, the platform is flexible such that any detector can be mounted to the spectrometer. The platform utilizes assembly techniques matching telecom reliability requirements, so besides the athermal properties the spectrometers can be used in very rugged environments.

NIR Capturing images with spectral information in the mid-infrared

Jeppe Seidelin Dam, Peter Tidemand-Lichtenberg and Christian Pedersen, DTU Fotonik

We demonstrate a method to capture images containing spectral information in the infrared. The method is based on sum frequency mixing of light, which allows for transformation of mid-infrared radiation to near visible light, allowing for use of a regular silicon based camera for detection. Combined, this leads to much improved sensitivity over existing methods for infrared imaging. The principle is generic and can be applied towards a multitude of different applications.

Supercontinuum kilder i spektroskopi-anvendelser

Carsten L. Thomsen og Frederik D. Nielsen, NKT Photonics, and Casper Larsen, DTU Fotonik, Denmark

Superkontinuum lyskilder er i dag en veletableret teknologi med et væld af anvendelses muligheder i den optiske industri. Det brede emission spektrum kombineret med en række filter teknologier, har vist sig særdeles attraktivt f.eks. i forbindelse med bio-imaging og spektroskopi.

I præsentationen her vil de nuværende anvendelser af Superkontinuum blive præsenteret, sammen med teknologierne som knytter Superkontinuum sammen med anvendelserne.

Raman spectroscopy: A non-destructive and on-site tool for control of food quality?

S. Hassing, Institute of Innavation and Technology (ITI)), Faculty of Engineering, University of Southern Denmark, Campusvej 55, DK-5230 Odense M, Denmark

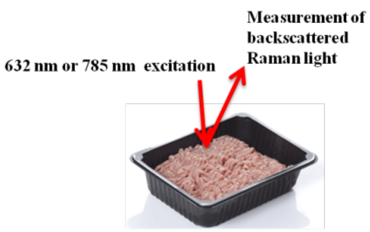
In recent years there has been an increasing focus from the consumers on food quality i.e. unwanted substances such as bacteria, pesticides, drug residues and additives as well as on food composition including nutritional value, healthy additives, antioxidants and the contents of selected fatty acids. This is also reflected in increasing interest for organic food products. It seems therefore appropriate to develop substance specific, nondestructive and fast measuring techniques that can be used close to the consumer, for monitoring different properties of food products.

Raman spectroscopy is a non-destructive optical technique, in which the sample is illuminated with laser radiation within the NIR, Visible or UV regions, which excites the constituent molecules in the sample to vibrate. A vibrational Raman spectrum of the molecule is obtained by collecting the in-elastically scattered light. Each molecule present in the sample has a characteristic set of nuclear vibrations and thus the sample as a whole has a unique "fingerprint" vibrational signature. Raman spectra can be obtained as reflectance measurements, which mean that samples can be investigated with no or very little sample preparation.

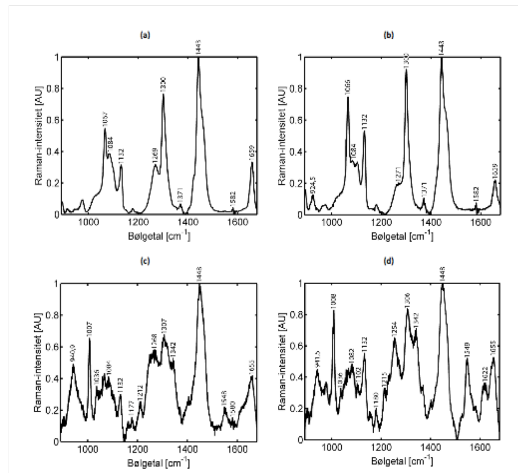
The talk will focus on the applicability of Raman spectroscopy as a non-destructive and molecule specific tool for monitoring food quality. The possibilities and challenges are illustrated through the discussion of three rather different case studies:

1. Detection of pesticides on fruits and vegetables using surface enhanced Raman spectroscopy (SERS)
2. Classification of nearly identical anti-oxidants using 3-way multivariate analysis of resonance Raman data.

3. Revelation of a pork content in minced lamb products using Raman Imaging



Minced lamb product to be tested for a pork content



Average spectra : (a) pork-fat, (b) lamb-fat, (c) pork-meat , (d) lamb-meat

Terahertz spectroscopy – yesterday, today and tomorrow.

Prof. Peter Uhd Jepsen, DTU Fotonik,

THz spectroscopy exploits the farthest region of the infrared, at very long wavelengths. In this interesting spectral range we observe fingerprint spectra of explosives and other solid chemicals, we observe the interplay between molecules in the liquid phase, and we observe the motion of electrons in semiconductors. Bordering the microwave and optical regime, the THz region has traditionally been difficult to access. Recent technological developments have changed this, and today portable, high-performance spectroscopy tools for investigation of the THz range is available.

In this presentation I will briefly outline the technological challenge for THz spectroscopy, give selected examples of spectroscopic applications, and demonstrate portable instrumentation for THz spectroscopy and imaging.

Efficient and Durable Linear Variable Filters and Dichroics

Henrik Fabricius & Michael Rodas Lorenzen, DELTA Light & Optics, Venlighedsvej 4, 2970 Hørsholm

DELTA has developed a series of highly efficient and durable linear variable filters and dichroics –made of a single quartz substrate with dense UHC surface coatings – ensuring minimal auto fluorescence and high laser damage threshold.
It is possible to form a variable band-pass by sliding a couple of highly efficient linear variable edge filters (LWP and SWP type). Wavelength range at present is 310 – 850nm with a guaranteed out of band blocking of at least OD3 in the whole range from 400nm to 850nm.
An advanced linear variable dichroic has been developed offering minimal polarization splitting as well as wideband blocking towards shorter wavelength. It increases blocking of excitation light by 2 – 3 decades in fluorescence applications.

The filters and dichroics are slide able with a present length of 60mm. Spot-size and opening angle of the light incident on the filters must be limited, in order to get the best out of the filters.
It is for example possible to form a wavelength selector for the super continuum light source. The opening angle of such a laser is very small – and it is recommended to focus the laser beam - that is typically 1 – 2 mms wide – by a factor of 3 – at the filters – in order to get the best out of them.
The situation is different in case the same filters are used with a xenon flash lamp. The arc is quite narrow but it is necessary to work with a certain opening angle in order to collect enough light from the arc. It is recommended to try to reduce the opening angle of the light incident on the filters by increasing the size of the image of the arc by a factor of 3 – as energy throughput increases by at least the same factor – assuming a fixed width of in example 1.5mm of the aperture in front of the filter.

Near Infrared Spectroscopy for Food Analysis

Håkan Wedelsbäck, Senior Scientist, FOSS, Denmark

Near Infrared (NIR) spectroscopy is based on the absorption of electromagnetic radiation in the wavelength range 780–2500 nm. NIR spectra of food comprise broad absorption bands arising from overlapping overtones and combinations of molecular vibrational modes involving C-H, O-H and N-H chemical bonds. The major advantage of NIR is that usually no sample preparation is necessary, making the analysis method simple, fast and well fit for food analysis.

For more than twenty years FOSS has been on the market with world class NIR instruments for food analysis. The instruments are used In Lab, In Process At/In-Line and On-Farm.
This presentation of NIR Spectroscopy for Food Analysis will cover the historical background, the link to IR Spectroscopy, instrument design, performance requirements, standardisation of instrument and some typical applications.

Spektroskopisk måleteknik 190 nm – 25000 nm i industrielle anvendelser

Seniorforsker Sønnik Clausen, Risø DTU, Denmark

Risø DTU har stor erfaring med on-line gas analyse baseret på UV og IR spektroskopi i industrielle anvendelser, f.eks. optisk måling af temperatur og gassammensætning i flammer, kraftværker og motorer.

Optiske egenskaber af materialer har betydning for energitransport ved varmestråling (byggematerialer, opvarmning af emner, materialer i procesanlæg). FTIR og gitter spektroskopi bruges til akkrediteret udmåling af materialers (fast stof, væske, gas) optiske egenskaber ved direkte sammenligning med termisk udstråling fra blackbodies, anvendelse af integrerende kugle, etc.

Measurement on pulsed light.

Yrjö Inkinen, Yokogawa Measurement Technologies, Finland AB

To generate pulses from a diode laser, it is driven with a pulsed electrical current. During the pulse, the electric current heats up the diode laser, causing a shift in the output wavelength. Consequently, the wavelength at the beginning and end of the laser pulse are different.
This property of diode lasers is currently studied at a university in Germany, using a Yokogawa Optical Spectrum Analyzer (OSA). The diode laser under examination is driven with a 1 to 10 Hz pulse repetition frequency and produces a 1 msec pulse width. The OSA records the optical spectrum by measuring optical power during a wavelength sweep.
During a sweep, it is assumed that the optical input signal is present, i.e. an assumption that is not valid when analyzing a pulsed input signal. Under normal circumstances, the absence of light between laser pulses will cause a distortion of the recorded spectrum, making it unsuitable for analysis. However, with the special recording methods offered by Yokogawa OSAs, the pulsed nature of the light is taken into account, and the true spectrum will be displayed, allowing a valid analysis.

Multispectral vision for assessing the quality of meat and meat products.

Claus Borggaard, Measuring Systems, Danish Meat Research Institute (DMRI).

Vision systems can be used to measure the quality of meat products when the traits of interest can be judged by looking at the surface. In the meat industry ordinary vision systems have been used to discriminate between fat and lean meat. Typical applications are classification of entire beef carcasses and measuring the area of e.g. the filet muscle which in many countries also is part of the carcass grading scheme. Vision systems can also be used to find a number of defects on the surfaces of muscles.

However, simple RGB colour measurements are not adequate if the product composition is more complex. Besides the fat in the meat, connective tissue and bone may also be present,- all three being white. Also, the background is often made of a white plastic material that is difficult to distinguish from the product components. Therefore, the DMRI has started using multispectral vision for measuring the macro constituents of meat products and for finding certain defects. Examples of this work will be presented.

Spectroradiometry for LED characterization

Carsten Dam-Hansen, Senior Scientist, DTU Fotonik

Radiospectroscopy is the absolute measurement of electromagnetic radiation within a specific wavelength range. For characterization of LED components, light sources and lamps we are interested in absolute measurement of the spectral power distribution, SPD, in the visible and near infrared region. Using integrating spheres for light collection setups for absolute total spectral flux is realized at the LED Light Lab at DTU Fotonik, Risø Campus. From these, both total radiant and luminous flux is determined and through electrical power measurement also the efficiency is determined. From the SPD colorimetric quantities like color coordinates, color temperature and color rendering indices are calculated. The facilities and special issues concerning LED measurements compared to traditional light sources are explained and examples from the “LED lighting quality program”, a project supported by the Danish Energy Association are presented.

Spectral design of new dynamic LED light sources.

Anders Thorseth, Post.Doc. DTU Fotonik

The use of LED technology in lighting applications, termed Solid State Lighting, is increasing drastically these years due to increasing flux and efficiency of LED components. The advantages of using Solid State Lighting is not only energy savings but the possibility to create new dynamic light sources that can be varied in color temperature and achieving color rendering properties. New LED light sources are constructed as clusters of colored LEDs. Modeling and optimization of the control of the light from the individual LEDs is a necessity for the desired operation of the new dynamic light source. Detailed knowledge of the spectral power distribution as a function of operating current and temperature is required for the modeling and optimization. Examples of new high color quality dynamic white light sources that can be tuned from warm white light at 2700 K to cold white light at 6500 K are presented.

Next generation optical sensing solutions

Romero Kicken OEM Account Manager EMEA, Ocean Optics

Ocean Optics and it's daughter Ocean Thin Films have co-developed a suit of miniature spectroscopic instrumentation. The Goal is to solve many of the detection challenges faced in defence and security, medical, lighting, biotech, enviroment, etcetera. The presentation highlights the technological problems and bespoke solutions developed for successful deployment. Topics that shall pass are multispectral imaging, multi analyte vapour detection, novel optical filters and linear CCD detectors for real life applications.

Can colour be measured?

P.S. Ramanujam, DTU Fotonik, Denmark

Colour is a sensation. While wavelength can be measured with a spectrometer consisting of dispersive elements and colour insensitive detectors, detection of colour is accomplished by the eye, equipped with a lens, colour sensitive detectors, and a powerful processor in the form of brain. Sometimes this process results in unexpected phenomena. Different theories of colour vision have been proposed, such as the retinex theory of Land. In this lecture, we shall explore the land of colour vision.