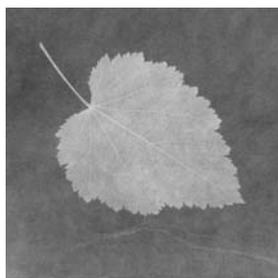


Electronic Excitation Energy Transfer

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This series of lectures has been presented at different occasions since 1992. The lecture notes are continually adapted, taking into account most recent research mainly on host-guest zeolite-dye based materials. References to research of other groups can be found in the publications I refer to.

The first chapter is intended as an overview. It is of interest for a general audience. The second chapter established a short link to the antenna system of green plants.

The following chapters are of more specific and more technical character, hence, they are intended for students and scientists who would like to plunge a bit deeper into the fascinating field of supramolecular organization of molecules by means of zeolites.

Bern, October 2004, Gion Calzaferri

1. Light-harvesting host-guest antenna materials for quantum solar energy conversion devices

1.1 Introduction

Zeolite L, an ideal host for supramolecular organization of dyes
Filling the channels with dye molecules
Some dyes which have been inserted in zeolite L
Orientation of the dyes in the channels
Dye loaded zeolite L crystals as nanolasers?
Radiationless transfer of electronic excitation energy
Förster energy transfer, a demonstration experiment
Intrazeolite diffusion kinetics monitored by energy transfer

1.2 Light-harvesting host-guest antenna materials

Three stages of organization
Electronic excitation energy migration
One dimensional energy transfer; phase boundary
Second stage of organization; the stopcock principle
Third stage of organization; coupling to an external device
Monodirectional materials

1.3. Challenges for developing antenna sensitized devices for solar energy conversion and LED's

2. Photosynthesis of green plants

2.1 Water

2.2 The antenna system

2.3 The Z-scheme

3. Energy transfer EnT

- 3.1 Transfer of vibrational, rotational, and translational energy
- 3.2 Transfer of electronic excitation energy
- 3.3 Very weak interaction, a semiclassical approach
 - 3.3.1 Dipole-dipole interaction
 - 3.3.2 Summary
 - 3.3.3 Energy migration
 - 3.3.4 Comment on the dipole-dipole interaction and on the orientation factor κ
- 3.4 Förster theory
 - 3.4.1 Weak interaction between donor and acceptor molecules
 - 3.4.2 Förster energy transfer radius R_0
 - 3.4.3 Dipole-dipole mechanism: selection rules
 - 3.4.4 Examples for spectral overlap and Förster radius
 - 3.4.5 Calculating the spectral overlap from experimental data
 - 3.4.6 A demonstration experiment for Förster energy transfer

4. Material aspects of dye loaded zeolite L

- 4.1 Zeolites, a short introduction
- 4.2 Zeolite A, an illustrative example
- 4.3 Structure and morphology of zeolite L
- 4.4 Synthesis of zeolite L crystals
- 4.5 Inner and outer surface of a zeolite L crystal
- 4.6 Insertion of molecules into the channels
 - 4.6.1. Preparation of Sandwich materials
- 4.7 Kinetics of the insertion process by ion exchange
 - 4.7.1 Kinetics of the insertion of two randomly mixed luminescent dyes monitored by EnT
 - 4.7.2 Exit kinetics and reversible insertion and release of molecules
 - 4.7.3 Photochromism
- 4.8 Orientation and organization of the dye molecules in the channels
 - 4.8.1 Organization of the dye molecules in the channels
- 4.9 Molecules that have been inserted in zeolite L
- 4.10 Addition of stopcock molecules
- 4.11 Ordering individual crystals on a surface or in a polymer
- 4.12 Monodirectional materials

5. Dynamics of energy transfer phenomena

5.1 Introduction

5.2 Luminescence intensity dynamics in homogeneous systems

- 5.2.1 A demonstration experiment
- 5.2.1 Data analysis of EnT phenomena in homogeneous media
 - A) Steady state measurements
 - B) Time resolved measurements
 - C) Increase of the acceptor luminescence: detailed derivation of the formula

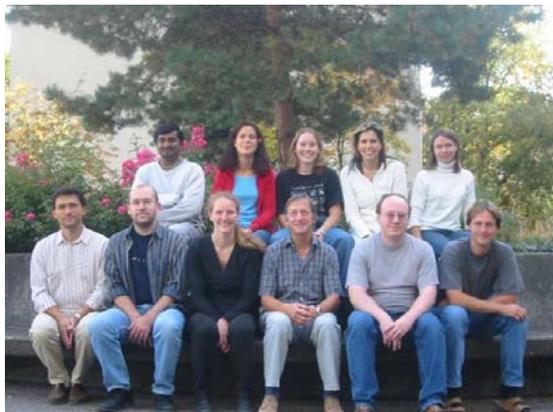
5.3 Luminescence intensity dynamics in organized systems

- 5.3.1 Selected systems
- 5.3.2 Distribution of the chromophores in an ordered host-guest material
- 5.3.2 Markow chain treatment of EnT in an ordered host-guest material

5.4 3-dimensional, 2-dimensional, and 1-dimensional EnT

I would like to
who have
made this
success.

Dr. Takayuki Ban,
Olivia Bossart,
Dr. André Devaux,
Dr. Stephan Glaus,
Katsiaryna Lutkouskaya,
Claudia Leiggener,
Marc Meyer,
Claudia Minkowski,
Dr. Michel Pfenniger,
Dr. Mikalai Yastkou,
René Bühler



thank all those
contributed to
research a



Dr. Dominik Brühwiler,
Dr. Antonio Currao,
Dr. Niklaus Gfeller,
Stefan Huber,
Dr. Abderrahim Khatyr,
Dr. Huub Maas,
Dr. Silke Megelski,
Dr. Marc Pauchard,
Dr. Marieke van Veen,
Arantazu Zabala Ruiz,

NRP 47:

Energy collection, transport and trapping by supramolecular organization of dyes in hexagonal zeolite nanocrystals

EU:

Nanochannel (European Union Research Training Network *Nanochannel*)

NF:

Luminescent molecules and quantum dots in the cavities and channels of zeolites

BFE:

Photochemische, Photoelektrochemische und Photovoltaische Umwandlung und Speicherung von Sonnenenergie

Fruitful collaboration with scientists in Belarus, Belgium, France, Germany, Italy, Japan, Netherlands, and Switzerland is acknowledged.