PHOTOCHEMISTRY IN THE MICROWAVE FIELD

P. Müller, J. Literák, V. Církva, Petr Klán*

Department of Organic Chemistry, Faculty of Science, Masaryk University, Kotlarska 2, 611 37 Brno, Czech Republic

E-mail: klan@sci.muni.cz • **URL: http://cheminfo.chemi.muni.cz/photochem/**

A combined chemical activation by two distinctive kinds of electromagnetic radiation, microwave (MW) and ultraviolet/visible: energy of MW radiation is considerably lower than that of UV radiation; it is not sufficient to disrupt bonds of common organic molecules. The objective of microwave-assisted photochemistry is frequently, but not irreplaceably, connected to the electrodeless discharge lamp (EDL) which generates UV radiation when placed into the MW field.[1]

Technique

The electrodeless discharge lamp consists of a glass tube ("envelope") that is filled with an inert gas and an excitable substance, and it is sealed under a lower pressure of a noble gas. Spectral characteristics of EDLs are of a general interest for microwave photochemistry: the right choice of the filling material can provide a desirable ultraviolet radiation.

The microwave photochemical reactor (*see the figure*) is an essential tool for experimental work in this field.[2-8] Such an equipment allows simultaneous irradiation of the sample by both MW and UV/VIS radiation: EDL is placed into a reaction vessel located in the cavity of an oven. The MW field generated UV discharge inside the lamp that results in simultaneous UV and MW irradiation of the sample.

Pros ...

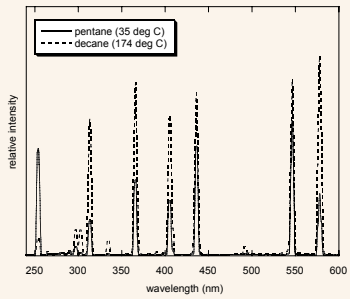
1. A simultaneous UV and MW irradiation of the sample.
2. Possibility to carry out photochemistry at high temperature.
3. Good photochemical efficiencies (EDL is "inside" the sample).
4. Simplicity of the experiment and a low cost of EDL.
5. The use of a commercially available microwave oven.
6. A "wireless" EDL operation.
7. The choice of the EDL material may modify its spectral output.

... and cons of the technique[1]

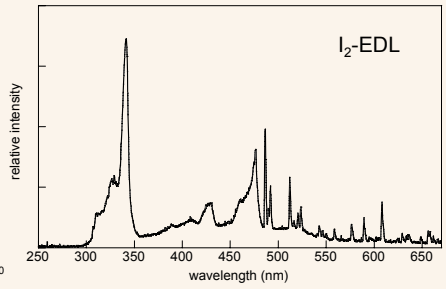
1. Technical difficulties to carry out the experiments at temperatures below the solvent b. p.
2. Higher safety precautions.
3. EDL overheating causes the lamp emission failure.
4. Polar solvents absorb MW radiation, thus lower the UV output efficiency of EDLs.

EDLs

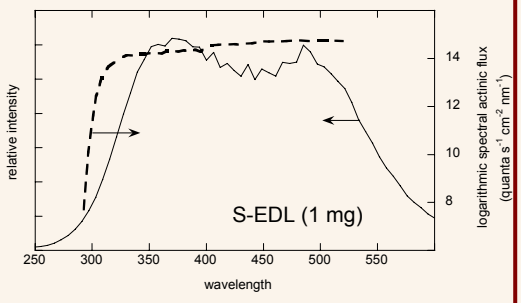
Hg-EDLs:

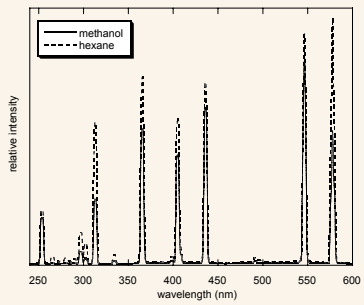


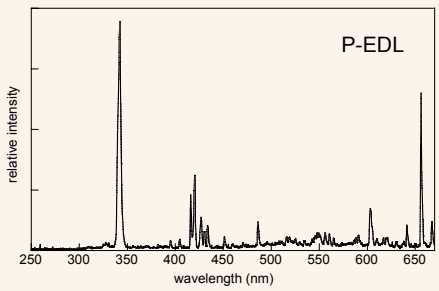
I_2- and P-EDLs

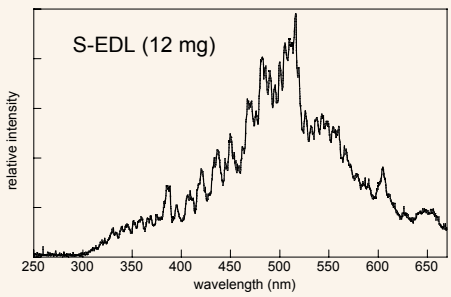


S-EDL vs. solar radiation flux









Conclusions

- **A new photochemical experimental technique was developed.**
- **Photochemical reactions were investigated in the MW field.**
- **No evidence for nonthermal microwave effects was observed.**

Outlook

- **MW-assisted photochemical degradation of pollutants**
- **Organic synthesis**

Literature:

1. P. Klán V. Církva, Microwave Photochemistry, in Microwaves in Organic Synthesis (A. Loupy, Ed.), Wiley-WCH, Weinheim, 2002, p. 463
2. Církva V., Hájek M.: *J. Photochem. Photobiol., A* **1999**, *123*, 21.
3. Klán P., Církva V., Hájek M.: *J. Photochem. Photobiol., A* **2001**, *140*, 185.
5. Klán P., Literák J., Hájek M.: *J. Photochem. Photobiol., A* **1999**, *128*, 145.
6. Klán P., Literák J. *Collect. Czech. Chem. Commun.* **1999**, *64*, 2007.
7. Klán P., Literák J., Relich S.: *J. Photochem. Photobiol., A* **2001**, *143*, 49.
8. Literak J., Relich S., Kulhanek P., Klan P. *Mol. Divers.* **2003**, *7*, 265-271.

Acknowledgements:
M. Hájek; D. Heger; A. Loupy; R. Růžička; M. Vavřík