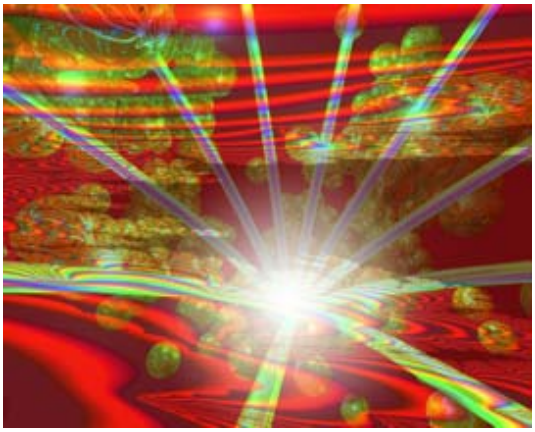
Monitoring of Reactive Oxygen Species in Material Sciences

Reactive Oxygen Species (ROS) are able to participate in chemical reaction during which light at very low intensities is emitted - a similar to the biological process of phagocytosis (cellular luminescence). The chemiluminescent light generation can be used in the area of quality control of various products.



These products include

- Plastics (e.g. PVC)
- Dyes, colours, tannic acid
- Oils, grease, lubricating grease, food oil
- Cosmetics
- Vitamins

Basically almost all compounds that require special additives (stabilisers) to get optimal properties are analysed: Sometimes the analyte itself is not the compound of interest but its stabilisers used to enhance special properties of the material.

These materials undergo oxygen dependent ageing processes, e.g. bleached dyes or rancid oils. Under real conditions these are usually very slow processes and therefore difficult to measure.
A lot of studies are done to investigate the degree of degradation, the kinetics of oxidation, etc. Generally the antioxidant efficiency is determined by oven ageing test, where samples are aged at elevated temperatures in air (oxygen). A lot of studies are done to investigate the degree of degradation, the kinetics of oxidation, etc.

Monitoring of slow processes

In thermodynamics there is a rule of thumb: "An increase in temperature of 10° doubles the reaction speed".
The samples are put into sealed heating chambers with transparent tops. Where the temperature is set to up 150 °C and an oxygen/nitrogen atmosphere is applied. The accelerator aging process results in an increase in ROS due to the continuous degradation of the stabilizers. The photons generated by the ROS can be detected with an ultrasensitive luminescent imaging device like the NightOWL LB 981.

The light intensitiy is very low, comparable to that of cellular luminescence. Long exposure times up to 1.5 hours are necessary to collect enough photons on the CCD chip. In contrast to cellular luminescence measurements in life sciences no luminol enhancement can be applied, since luminol could react with the sample. Similar to cellular luminescence kinetics readout is perfomed – sometime even days or even weeks.

To get the low background needed for this extremely high sensitivity the camera is cooled to –70 °C. As this can be achieved at ambient temperature below 30 °C only temperature isolated sample compartments as described earlier are used.

Benefits of NightOWL LB 981:

The NightOWL system offers various benefits for its use in material science.

- Ultrasensitive CCD camera with low noise (background) for most efficient detection even over weeks
- WinLight software has an excellent image sequence tool offering the possibility to take sequential images for kinetics analysis
- Usage Peltier air cooling system is maintenance free and cheap in operation which is especially important in long-term kinetic applications (e.g. overnight or over weekend: no nitrogen re-filling)
- Large imaging area enables parallel monitoring of multiple samples
- Via controllable digital interfaces and main sockets inside the cabinet the heat chamber can be operated through WinLight software
- Customisation is possible, e.g. additional fan to protect camera from heat

The NightOWL LB 981 system is being used continuously for years in material testing field of applications (e.g, at BASF, Germany).