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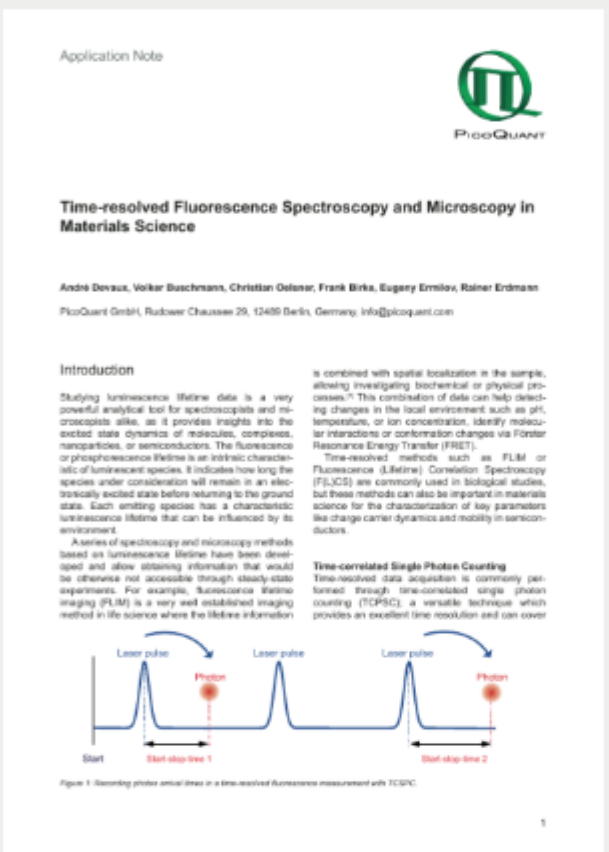
Application Note

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Time-resolved Fluorescence Spectroscopy and Microscopy in Materials Science

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Introduction

Studying luminescence lifetime data is a very powerful analytical tool for spectroscopists and microscopists alike, as it provides insights into the excited state dynamics of molecules, complexes, nanoparticles, or semiconductors. The fluorescence or phosphorescence lifetime is an intrinsic characteristic of luminescent species. It indicates how long the species under consideration will remain in an electronically excited state before returning to the ground state. Each emitting species has a characteristic luminescence lifetime that can be influenced by its environment.

A series of spectroscopy and microscopy methods based on luminescence lifetime have been developed and allow obtaining information that would be otherwise not accessible through steady-state experiments. For example, fluorescence lifetime imaging (FLIM) is a very well established imaging method in life science where the lifetime information is combined with spatial localization in the sample, allowing investigating biochemical or physical processes.[1] This combination of data can help detecting changes in the local environment such as pH, temperature, or ion concentration, identify molecular interactions or conformation changes via Förster Resonance Energy Transfer (FRET).

Time-resolved methods such as FLIM or Fluorescence (Lifetime) Correlation Spectroscopy (FLCS) are commonly used in biological studies, but these methods can also be important in materials science for the characterization of key parameters like charge carrier dynamics and mobility in semiconductors.

Time-correlated Single Photon Counting

Time-resolved data acquisition is commonly performed through time-correlated single photon counting (TCSPC), a versatile technique which provides an excellent time resolution and can cover

Figure 1: Recording photon arrival times in a time-resolved fluorescence measurement with TCSPC.

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Time-resolved Fluorescence Spectroscopy and Microscopy in Materials Science

Studying luminescence lifetime data is a very powerful analytical tool to gain insights into the excited state dynamics of molecules, nanoparticles, or semiconductors. Time-resolved methods such as Fluorescence Lifetime Imaging are commonly used in biological studies, but these methods are also relevant for material science. This paper provides an introduction to using these methods for the characterization of key parameters like charge carrier dynamics and mobility in semiconductors.

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