In recent years, a number of approaches have emerged that enable far-field fluorescence imaging beyond the diffraction limit of light, namely super-resolution microscopy. The success of these techniques culminated in the award of the Nobel Prize in chemistry in 2014 to Eric Betzig, Stefan W. Hell and William E. Moerner. A brief introduction is given into these techniques with a focus on the photophysical needs of the fluorescent molecules.

It is demonstrated how the fluorescence properties of different fluorophores can be manipulated and made suitable for super-resolution microscopy using photoinduced redox reactions.\(^1\) For instance, photobleaching and blinking is minimized by recovering reactive intermediates. To achieve this, oxygen is removed and triplet as well as charge separated states are quenched using a formula that contains reducing as well as oxidizing agents, i.e. a reducing and oxidizing system (ROXS).\(^2\)

The underlying ROXS concept represents a paradigm shift in photobleaching prevention and can be utilized to control the lifetime of dark states. Suitable fluorophores with high electron affinity can be switched off in a reductive environment and switched on again in an oxidizing environment. If both oxidants and reductants are present, blinking occurs with kinetics that can be arbitrarily controlled by varying reagent concentrations. These are excellent properties of a fluorophore that can be harnessed for super-resolution microscopy exploiting the subsequent localization of single fluorophores.\(^3\)

Finally, a concept is presented for fluorescent probes that show a superlinear fluorescence dependence on excitation intensity using single-photon excitation conditions. These probes are of high potential for subdiffraction resolution imaging in ordinary, commercial confocal microscopes.\(^4\)


