

of silicon clusters and nanoparticles, such as quantum confinement and surface passivation, are introduced, and contrasted with the current state of research on fluorescent silicon clusters and nanoparticles. Owing to the vast number of publications on this subject that can already be found in the literature, this book chapter cannot be exhaustive. Rather, it complements recent review articles on fluorescent nanoscale silicon (Dohnalová et al., 2014; Cheng et al., 2014; Priolo et al., 2014; Peng et al., 2014; McVey and Tilley, 2014; Montalti et al., 2015; Dasog et al., 2016).

1.2 Fundamental concepts for producing fluorescent nanoscale silicon

Bulk crystalline silicon is known as a poor light emitter because of its indirect band gap. Fluorescence is a relatively inefficient relaxation process in electronically excited indirect band gap semiconductors because fluorescence has to simultaneously occur with the absorption of a phonon of matching momentum. This mechanism is illustrated in more detail in figure 1.1. The entire electronic excitation and relaxation/fluorescence cycle is shown for direct and indirect band gap semiconductors.

The left-hand side of figure 1.1 shows an energy band schematic of a direct band gap semiconductor, characterised by the conduction and valence band maxima and minima being on top of each other. Photoexcitation of an electron follows an energetic pathway indicated by the vertical arrow, reaching from the top of the valence band and into the conduction band, from where it returns to recombine with the hole, inducing fluorescence. Photoexcitation using higher energies is possible, but less likely because of the decreasing density of states along the parabola, and indeed the fluorescence wavelength will remain unal-