Invited Talk

Highly Mismatched and Inhomogeneous Alloys in Photonic Device Applications

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Over a number of years there has been considerable effort devoted to developing new semiconductor systems and approaches to overcome the fundamental limitations of well-established materials for use in photonic devices [1,2]. Of these, the dilute bismide and dilute nitride systems have been of particular interest owing to the degree to which Bi or N atoms perturb the band structure, promising lasers with reduced losses, facilitating access to new wavelength ranges on conventional substrates, or as new approaches to spin-based devices. Other materials, such as GeSn or InAs quantum dots have separately been explored for their potential as laser active regions that may be directly integrated on silicon for photonic integrated circuit applications [3,4].

In all of these materials, a common theme is the challenge in achieving the optimum growth conditions required to produce high quality and uniform material that is suitable for the production of reliable devices. In this paper we explore the development of these systems and consider their common properties in terms of device applications. In particular, we show how the effects of inhomogeneity lead to carrier localization and unusual temperature-dependent behaviour which can be exploited to give rise to temperature stability [1]. We will also discuss the influence of defect-related recombination in a variety of materials systems and the extent to which this limits (or not) device performance [1]. The paper will conclude with a prognosis for the future development and exploitation of devices based upon these material systems.

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