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Radiation-induced Damage in Self-Assembled Quantum Dot Lasers

Self-assembled quantum dot (SAQD) devices have attracted much attention in recent years due to their superior performance over their quantum well (QW) counterparts - of particular interest to the aerospace industry is the radiation sensitivity of these devices. Despite research demonstrating the increased robustness of SAQD devices to irradiation by high-energy ions, as compared to their QW counterparts, very little is known about the radiation-induced failure mechanisms in SAQD devices. Such information would be highly useful in efforts to increase the radiation hardness of future devices for space applications.

The primary objective of our proposed program is to further characterize the radiation-induced damage in SAQD devices. The secondary objective of the program is to verify that SAQD devices in both edge emitting and vertical cavity geometries do have improved radiation hardness over QW devices. Three categories of devices will be studied: edge emitting SAQD lasers (QDLs), edge emitting QW lasers (QWLs), and SAQD vertical cavity surface emitting lasers (QD-VCSELs). These devices will be exposed to two classes of radiation (>100 keV and >1MeV), at space relevant doses. The devices will be monitored and tested periodically during radiation exposure to gain specific information about their failure mechanisms. Failed devices will be evaluated analytically using appropriate methods such as transition electron microscopy, secondary ion mass spectroscopy, and deep level transient spectroscopy.