Midgap States and Generalized Supersymmetry in Semi-infinite Nanowires CHUNG-YU MOU, BOR-LUEN HUANG, National Tsing Hua University, Taiwan, ROC, SHIN-TZA WU, National Chung-Cheng University, Taiwan, ROC — Edge states of semi-infinite nanowires in tight binding limit are examined. We argue that understanding these edge states provides a pathway to generic comprehension of surface states in many semi-infinite physical systems. It is shown that the edge states occur within the gaps of the corresponding bulk spectrum (thus also called the midgap states). More importantly, we show that the presence of these midgap states reflects an underlying generalized supersymmetry. This supersymmetric structure is a generalized rotational symmetry among sublattices and results in a universal tendency: all midgap states tend to vanish with periods commensurate with the underlying lattice. Based on our formulation, we propose a structure with superlattice in hopping to control the number of localized electronic states occurring at the ends of the nanowires. Other implications are also discussed. In particular, it is shown that the ordinarily recognized impurity states can be viewed as disguised midgap states.

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Date submitted: 14 Dec 2004   Electronic form version 1.4