SUPERDEV

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Superlattice Devices

From 1992-07-01 to 1995-06-30

Project details

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<th>Total cost:</th>
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<td>EU contribution:</td>
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<td>Coordinated in:</td>
<td>United Kingdom</td>
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Objective

The SUPERDEV working group is interested in trying to understand the mechanisms governing vertical, hot-electron transport, and carrier relaxation in III-V superlattice structures, and the potential application of superlattices to enhance the performance of existing heterostructure devices or to provide new device concepts.

Topics of interest to the group include: epitaxial growth of fine-period structures based on GaAs/AlGaAs and InGaAs/InAlAs/InP with emphasis on uniformity and interface sharpness; fabrication of heterostructures, particularly transistors with base regions of less than 100nm thick buried deep within the structure; developing theoretical descriptions of electronic transport in superlattices and determining the physical mechanisms governing hot-carrier transport and relaxation; incorporating superlattices in the base regions of heterojunction bipolar transistors to reduce base access resistance and transit times; and using superlattices structures as oscillators or for enhancing photodetectors and lasers.

The electronic properties and device exploitation of superlattice structures are being studied. The novel properties associated with superlattices have potential for enhancing the performance of existing heterostructure devices (e.g., heterojunction bipolar transistors, photodetectors, and lasers) and for providing new device concepts, such as superlattice oscillators.

During the first year 2 meetings have been held. At these meetings the work being carried out in the laboratories and the progress being made was described. Clear demonstrations have been made of miniband transport in gallium arsenic-aluminium gallium arsenic and gallium arsenic-aluminium arsenic superlattice structures, respectively. Esaki-Tsu negative differential resistance (NDR) has been observed in gallium indium arsenic-aluminium indium arsenic superlattices which extends up to 55 GHz. Light induced microwave oscillations in gallium arsenic-aluminium arsenic have also been observed in gallium arsenic-aluminium arsenic superlattices up to 90GHz. A fully self aligned process has been developed for the indium gallium arsenic-indium phosphorus heterojunction bipolar transistors. Transistors have been fabricated and tested. Novel long wavelength separate confinement heterostructure and graded index separate confinement heterostructure quantum well lasers have also been fabricated. Initial tests on the former gives threshold current densities of 1.9 kV A cm⁻² and device efficiencies of 0.16 mW mA⁻¹. Indium gallium arsenic-indium gallium arsenic-indium phosphorus quantum well lasers, a high gain gallium arsenic aluminium gallium arsenic avalanche photodetector and a unipolar quantum well avalanche photodetector are also under investigation.

ACTIVITIES

The group holds biennial meetings on a site-rotational basis to discuss their work on superlattices and other issues relevant to the field of superlattice devices. These meetings also include tours of the host’s laboratories. Further bilateral or multilateral meetings will be held to discuss more specific topics, e.g., on growth, fabrication, theory, etc., or to enhance collaborations. Members of the group will attend international conferences and also publish their work. The group will participate in workshops involving other ESPRIT nanoelectronics consortia (3042, 3043, 3133, 6312, 6536, 6719, 6849) and, if appropriate, it will assist these consortia in the organisation of up to one international workshop during the life of the group.
POTENTIAL

Research on superlattices carried out by the group will lead to general advances in the growth and fabrication of fine-period heterostructure devices. This is a very fruitful area of research which will benefit from the exchange of views and information dissemination within the Working Group. The understanding of the underlying physical processes of vertical transport in superlattices will also broaden the base knowledge in low dimensional semiconductor structures. This is seen as a necessary stepping-stone towards the exploitation of superlattice structures for the enhancement of existing devices and for realising novel device concepts. The devices of interest to the group are perceived to have potential for the field of microelectronics and optoelectronics for future IT requirements.

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