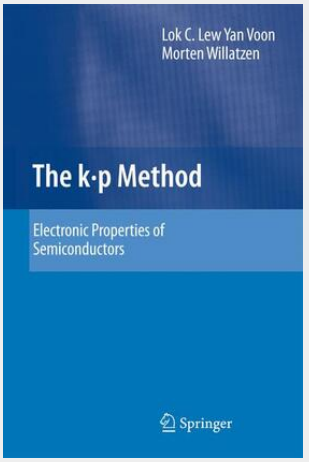
Willatzen / Lew Yan Voon

The k p Method

Electronic Properties of Semiconductors



I ?rst heard of k·p in a course on semiconductor physics taught by my thesis adviser William Paul at Harvard in the fall of 1956. He presented the k·p Hamiltonian as a semiempirical theoretical tool which had become rather useful for the interpre- tion of the cyclotron resonance experiments, as reported by Dresselhaus, Kip and Kittel. This perturbation technique had already been succinctly discussed by Sho- ley in a now almost forgotten 1950 Physical Review publication. In 1958 Harvey Brooks, who had returned to Harvard as Dean of the Division of Engineering and Applied Physics in which I was enrolled, gave a lecture on the capabilities of the k·p technique to predict and ?t non-parabolicities of band extrema in semiconductors. He had just visited the General Electric Labs in Schenectady and had discussed with Evan Kane the latter's recent work on the non-parabolicity of band extrema in semiconductors, in particular InSb. I was very impressed by Dean Brooks's talk as an application of quantum mechanics to current real world problems. During my thesis work I had performed a number of optical measurements which were asking for theoretical interpretation, among them the dependence of effective masses of semiconductors on temperature and carrier concentration. Although my theoretical ability was rather limited, with the help of Paul and Brooks I was able to realize the capabilities of the k·p method for interpreting my data in a simple way.

This book presents a detailed exposition of the formalism and application of k.p theory for both bulk and nanostructured semiconductors. For bulk crystals, this is the first time all the major techniques for deriving the most popular Hamiltonians have been provided in one place. For nanostructures, this is the first time the Burt-Foreman theory has been made accessible. Thus, the reader will gain a clear understanding of the k.p method, will have an explicit listing of the various Hamiltonians in a consistent notation for their use, and a set of representative results. In addition, the reader can derive an excellent understanding of the electronic structure of semiconductors.

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