PACKAGE ID - 000546IBMPC00 PC-1D

KWIC TITLE - Semiconductor Device Analysis on Personal Computers

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LIMITATION CODE -COPY **AUDIENCE CODE -** LIM

COMPLETION DATE - 02/08/1993 **PUBLICATION DATE -** 04/01/1992

DESCRIPTION - PC-1D models the internal operation of bipolar semiconductor devices by solving for the concentrations and quasi-one-dimensional flow of electrons and holes resulting from either electrical or optical excitation. PC-1D uses the same detailed physical models incorporated in mainframe computer programs, yet runs efficiently on personal computers. PC-1D was originally developed with DOE funding to analyze solar cells. That continues to be its primary mode of usage, with registered copies in regular use at more than 100 locations worldwide. The program has been successfully applied to the analysis of silicon, gallium-arsenide, and indium-phosphide solar cells. The program is also suitable for modeling bipolar transistors and diodes, including heterojunction devices. Its easy-to-use graphical interface makes it useful as a teaching tool as well.

PACKAGE CONTENTS - Media Directory; SAND-91-0516 Rev.; Software Abstract; Media contains Executable Modules, Auxiliary Material; Sample Problem Input Data;

SOURCE CODE INCLUDED? - No

MEDIA QUANTITY - 2 5.25 Diskettes

METHOD OF SOLUTION - A device is automatically divided into elements of varying length, with the size set to provide smooth solution functions and insure numerical convergence. For each element, the time-dependent semi-classical drift-diffusion equations for

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METHOD OF SOLUTION -(CONT) electron and hole transport in semiconductors and Poisson's equation of electrostatics are written in discrete form. Physical factors accounted for in the model include position-dependent bandgap, electron affinity, intrinsic carrier concentration, bandgap narrowing, mobility, recombination lifetime, velocity saturation, and photogeneration; temperature and doping dependence of key parameters; textured surfaces; light trapping; and antireflection coating. The equations are solved by the iterative Newton method involving the direct solution of the Jacobian differential matrix.

COMPUTER - IBM PC

OPERATING SYSTEMS - IBM DOS 2.1 or later is required for interactive mode. IBM DOS 3.0 or later is required to run the program in batch mode. DOS 5.0 or later allows the graphics device driver to be loaded into high memory.

PROGRAMMING LANGUAGES - IBM Pascal 2.0 (95%), IBM Macro Assembler 2.0 (5%)

SOFTWARE LIMITATIONS - The device can be represented using a maximum of three materials, and can be divided into a maximum of 150 elements. A maximum of 50 time steps can be used in a transient solution. Although multidimensional effects can be approximated, the program is not designed to address problems with significant two- or three-dimensional effects. The program solves transient temporal problems, but does not solve for sinusoidal steady state. Although recombination centers can have different electron and hole cross-sections and be located anywhere in the bandgap, only one such recombination center is allowed. A maximum of three electrical contacts to the device are supported; these can be positioned anywhere within the device.

SOURCE CODE AVAILABLE (Y/N) - N

UNIQUE FEATURES - PC-1D's primary distinction is its flexible yet efficient menu-based graphical user interface for both input and output, combined with fast and efficient numerical algorithms which provide rapid solutions on personal computers. It is also the only semiconductor device simulation program currently available that fully treats light trapping in textured solar cells.

RELATED SOFTWARE - PC-1D version 1 was copyrighted and first released in 1985 by Iowa State University, where the program was originally developed. The copyright for versions 2 and 3 are held by Sandia Corporation. PC-1D incorporates within its executable program code certain Virtual Device Interface (VDI) modules copyrighted by IBM Corporation and used in this program under license from IBM to Sandia for this purpose. To run PC-1D, the user must have installed a memory-resident VDI graphics driver which matches the display in

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RELATED SOFTWARE -(CONT) use (CGA, EGA, or VGA). A separate program is provided with PC-1D to generate plots of solution variables using a HPGL-compatible plotter.

OTHER PROG/OPER SYS INFO - The documentation for PC-1D version 3 has been published as a Sandia Report, SAND91-0516. Copies of the executable program and the documentation are available free of charge to users engaged in photovoltaic research or development by contacting Paul A. Basore, Department 6213, Sandia National Labs, Albuquerque, NM 87185. The source code for PC-1D is available only by making special arrangements with Sandia.

HARDWARE REQS - The minimum hardware configuration for PC-1D requires an IBM PC, XT, AT, PS/1, PS/2, or compatible; 512 Kbytes of RAM; an 8087-family numeric coprocessor chip, a CGA, EGA, or VGA graphics adapter and display; and one diskette drive (360 Kbytes or more). Optional features supported include a mouse compatible with Microsoft, Mouse Systems, IMSI, TopView, or IBM; and pen plotters compatible with IBM or HP. 640 Kbytes of installed RAM is necessary when either EGA or VGA graphics modes are used, or if a plotter is to be used.

TIME REQUIREMENTS - A typical silicon solar-cell simulation consisting of 60 elements requires 5 seconds of solution time for each applied voltage on a 20-MHz 80386-based computer. An additional 10 seconds are needed for optical calculations. Sixteen applied voltages are adequate to trace an I-V curve and find the maximum-power point, for a total of 90 seconds per curve.

REFERENCES - Paul A. Basore, PC-1D Installation Manual and User's Guide Version 3, SAND91-0516, April 1992.

ABSTRACT STATUS - Submitted 12/21/92. ESTSC released package AS-IS 02/08/93.

SUBJECT CLASS CODE - WT

KEYWORDS -
COMPUTER PROGRAM DOCUMENTATION
P CODES
CHARGED-PARTICLE TRANSPORT
SEMICONDUCTOR DEVICES
SOLAR CELLS

EDB SUBJECT CATEGORIES -
990200 665000

SPONSOR - DOE/CE

PACKAGE TYPE - AS - IS