

# PHOTOVOLTAIC RESEARCH NEEDS: INDUSTRY PERSPECTIVE

MOBIL TYCO SOLAR ENERGY CORP.

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(Presented by J.P. Kalejs)

## Research Objectives of PV Industry

- TO UNDERSTAND, DEVELOP AND IMPLEMENT NEW PROCESSES FOR THE PURPOSES OF MANUFACTURING COST REDUCTION AND REVENUE ENHANCEMENT.
- TO DEVELOP DETAILED UNDERSTANDING OF ONGOING PROCESSES TO MAINTAIN INTEGRITY OF THE PROCESS AND TO ENHANCE YIELDS AND EFFICIENCIES.
- TO MAINTAIN AWARENESS OF NEW DEVELOPMENTS AND CAPITALIZE ON THESE TO SUSTAIN AND ENHANCE MARKET SHARE AND PROFITABILITY.

## Features of R&D Geared Toward Industry Needs

- RELATIVELY SHORT RANGE (1-5 YEARS).
- INTERACTIVE - INDUSTRY, GOVERNMENT, UNIVERSITIES.
- RESEARCH IS MORE DEVELOPMENTAL IN NATURE AND LESS FUNDAMENTAL.
- RESEARCH NEEDS TO BE GENERAL IN NATURE RATHER THAN PRODUCT OR PROCESS SPECIFIC - PROBLEMS PERTAINING TO PROPRIETARY TECHNOLOGY.
- DIFFICULTY OF TECHNOLOGY TRANSFER (EXAMPLE OF SUCCESSFUL TECHNOLOGY TRANSFER IS THE EVA ENCAPSULATION TECHNOLOGY DEVELOPED UNDER DOE/JPL SPONSORSHIP).

## Research Categories

MATERIALS

DEVICES

PROCESSES

RELIABILITY

## Materials Research

### MATERIALS PRODUCTION

- RATE EFFECTS IN CRYSTAL GROWTH.
- MENISCUS AND INTERFACE PHENOMENA.
- STRESS PROBLEMS IN HIGH RATE, LARGE AREA SHEET GROWTH.
- IMPURITY INCORPORATION AND DISTRIBUTION EFFECTS AND MECHANISMS.

### MATERIALS PROPERTIES

- ELECTRONIC PROPERTIES OF IMPERFECT AND IMPURE CRYSTALS.
- PROBLEMS PERTAINING TO INHOMOGENEOUS CRYSTALS.
- THE INFLUENCE OF CARBON AND OXYGEN IN SILICON ON ELECTRONIC PROPERTIES.
- INFLUENCE OF THERMAL PROCESSES ON ELECTRONIC AND MECHANICAL PROPERTIES.
- ELECTRONIC EFFECTS OF GRAIN BOUNDARIES, DISLOCATIONS, IMPURITY INHOMOGENEITIES.

### MATERIALS ANALYSIS

- CENTRALIZED ANALYTICAL AND CHARACTERIZATION SERVICES INCLUDING CHEMICAL, PHYSICAL AND ELECTRICAL CHARACTERIZATION.
- NON-DESTRUCTIVE TECHNIQUES FOR RAPID MATERIALS PROPERTY ANALYSIS INCLUDING LIFETIME MEASUREMENTS, CRACK DETECTION IN SOLAR CELLS, ETC.
- CHARACTERIZATION OF MATERIALS PRONE TO HIGH IMPURITY AND DEFECT CONCENTRATIONS.

### Device Research

- ANALYSIS AND DEVELOPMENT OF DEVICE STRUCTURES FOR MAXIMIZING CONVERSION EFFICIENCIES.
- R & D ON CONDUCTING OXIDES, HETEROJUNCTIONS, JUNCTION PROFILES, GRADED JUNCTIONS. VOLTAGE ENHANCEMENT TECHNIQUES.
- DEVICE CONFIGURATIONS SUITED TO MATERIAL PRONE TO CONTAIN A HIGH DENSITY OF IMPERFECTIONS AND IMPURITIES.

## Process Research

### PROCESS TECHNOLOGY

- RAPID PROCESSING TECHNOLOGY
  - HIGH SPEED JUNCTION FORMATION AND METALLIZATION TECHNOLOGIES AND METHODS FOR DEPOSITION OF MULTIPLE AR COATINGS, METAL CONTACTS.
- BEAM PROCESSING
  - LASERS, E-BEAMS, MICROWAVES FOR DIFFUSION, METALLIZATION, SINTERING, JUNCTION ISOLATION.
- MATERIALS ENGINEERING TO DEVELOP TECHNIQUES SUCH AS INTRINSIC GETTERING, SELECTIVE HEATING OF CRYSTALS FOR PERFORMANCE ENHANCEMENT.
- DEVELOPMENT OF BASE METAL PASTES FOR SCREEN PRINTED CONTACTS. LASER ASSISTED PLATING TECHNIQUES.
  - AUTOMATION AND MATERIALS HANDLING
- PROCESS DEVELOPMENTS GEARED TOWARDS THE NEEDS OF AUTOMATION AND LARGE SCALE MANUFACTURE.
- YIELD ENHANCEMENT TECHNIQUES.
- TECHNOLOGY TO DETECT BROKEN CELLS IN PROCESS.
- FUNDAMENTAL UNDERSTANDING OF FRACTURE MECHANICS OF SILICON, RESIDUAL STRESS EFFECTS, THICKNESS EFFECTS AND EDGE QUALITY EFFECTS.

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## Reliability

- FIELD TESTING OF MODULES.
- ESTABLISHMENT OF STANDARDS. CALIBRATION OF STANDARD CELLS.
- ACCELERATED CELL AND PANEL TESTING. WEAR OUT AND FAILURE MECHANISMS.
- RELIABILITY PHYSICS - R & D IN THE PHYSICS OF RELIABILITY OF MATERIALS, DEVICES, METALLIZATION SYSTEMS, INTERCONNECTS, PACKAGES.