UNION CARBIDE CORP. POLYSILICON STATUS AND PLANS

JET PROPULSION LABORATORY

M.H. Leipold

UCC Silane-to-Silicon Process

SEQUENCE OF PROCESS STEPS

- SILANE SYNTHESIS
  - HYDROCHLORINATION:

    $$Si(MG) + 3SiCl_4 + H_4 \rightleftarrows 4HSiCl_3$$

  - REMOVE METAL IMPURITIES AS CHLORIDES
  - REDISTRIBUTION $2H\ SiCl_3 \rightleftarrows SiH_4 + SiCl_4$

    $$2H_2SiCl_2 \rightleftarrows SiH_4 + SiCl_4$$

  - DISTILLATION/PURIFICATION OF SiH_4 AND CHLOROSILANES

- SILICON CONVERSION (SiH_4 TO Si)
  - FLUIDIZED-BED Si DEPOSITION ON SEED PARTICLES (FREE-FLOWING Si PARTICLES > 300μM)
  - FREE SPACE REACTOR PYROLYSIS AND THEN MELTING/SHOTTING (> 2 MM SHOT)

- RECYCLING OF H_2 AND $SiCl_4$

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Contract Progress

- CONTRACT (#954334) STARTED OCTOBER, 1975
- PROCESS FEASIBILITY EXPERIMENTALLY DEMONSTRATED
- SILANE/SILICON PROCESS DESIGN COMPLETED
- COST ESTIMATES INDICATE CAPABILITY OF MEETING THE <$14/KG (1980 $) Si PRICE GOAL
- SILANE SYNTHESIS APPROACH WELL ESTABLISHED
  - NEEDS TO BE TESTED IN CONTINUOUS STEADY-STATE OPERATION OF EPSDU (EXPERIMENTAL PROCESS SYSTEM DEVELOPMENT UNIT)
  - ENGINEERING DESIGN COMPLETED
  - EQUIPMENT FOR EPSDU FABRICATED
  - CIVIL CONTRACT AT EAST CHICAGO UCC SITE COMPLETED
  - JPL/DOE FUNDING FOR SILANE SYNTHESIS EPSDU STOPPED BEFORE MECHANICAL AND ELECTRICAL INSTALLATIONS
- CONVERSION OF SILANE TO SILICON:
  - FLUIDIZED-BED APPROACH APPEARS PROMISING, BUT NEEDS FURTHER R & D. EFFORT WILL CONTINUE UNDER DOE/JPL CONTRACT
  - FREE-SPACE REACTOR APPROACH IS LESS FAVORABLE. MAJOR PROBLEMS IN POWDER HANDLING, MELTING, SHOTTING OPERATION AND PURITY CONTROL
- CONTRACT MODIFICATIONS ARE UNDERWAY. THESE ARE EXPECTED TO RESULT IN UCC OPERATING EPSDU AT THEIR EXPENSE WITH PERFORMANCE RESULTS AVAILABLE TO DOE/JPL

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Status: UCC Plans for Polysilicon Production

- ON MAY 1, 1981, UCC ANNOUNCED ITS INTENTION TO BUILD A 1000 MT/YR COMMERCIAL POLY SI PLANT IN WASHINGTON STATE. DESIGN TO BE BASED ON THE DATA FROM THE SILANE EPSDU; KOMATSU (SIEMENS TYPE) DEPOSITION REACTORS

- EPSDU EQUIPMENT MOVED (FROM EAST CHICAGO) AND BEING INSTALLED IN WASHOUGAL, WASHINGTON. THIS IS A UCC PILOT PLANT PROJECT. OPERATION EXPECTED IN FALL 1982 (USING KOMATSU REACTORS)

Future Activities and Prospects

- ADVANCED SILANE SYNTHESIS TECHNOLOGY (FBR) TO BE TESTED IN PILOT PLANT AT UCC ELECTRONIC MATERIALS TEST CENTER AS FINAL PHASE OF JPL/DOE R & D INVESTIGATION

- THE DEVELOPMENT OF SILANE/SILICON PROCESS CONTINUES TOWARD PROVIDING A LOW-COST POLY SI TECHNOLOGY. ALTHOUGH MANY FUNDING/SCHEDULE CHANGES OCCURRED, THE SUCCESSFUL CONTINUATION OF THIS PROGRAM SHOWS THAT THIS APPROACH REPRESENTS AN EFFECTIVE WAY OF CONDUCTING COOPERATIVE ENERGY R & D BY THE INDUSTRY AND THE GOVERNMENT

- FSA/DOE GOAL OF < $14/KG SILICON CAN ONLY BE ACHIEVED BY SILANE/SILICON PROCESS WHICH INCORPORATES NEW TECHNOLOGY DEPOSITION REACTOR - SUCH AS FBR BEING INVESTIGATED