N87-16444

# POLYCRYSTALLINE SILICON RESEARCH AND DEVELOPMENT

UNION CARBIDE CORPORATION

S. Iya

| TECHNOLOGY | REPORT DATE |
|---|---|
| POLYCRYSTALLINE SILICON R&D | APRIL 30, 1986 |
| **APPROACH**<br>SILANE DECOMPOSITION IN A FLUIDIZED BED REACTOR<br><br>**CONTRACTOR**<br>UNION CARBIDE CORPORATION | **STATUS**<br>• SHORTER FLUID BED REACTOR WAS INSTALLED & OPERATED<br>• LONG DURATION TEST RUNS WERE CONDUCTED USING QUARTZ & POLYSILICON LINERS<br>• PRODUCT SAMPLES WERE ANALYZED & ALSO DELIVERED TO JPL<br>• FINAL REPORT IS NEARING COMPLETION |
| **GOALS**<br>• DEMONSTRATE PROCESS FEASIBILITY<br>• DETERMINE OPERATING WINDOW<br>• CONDUCT LONG-DURATION TESTS<br>• DEMONSTRATE SILICON PURITY | |

## Overview of Recent FBR Test Runs

| RUN NO. | DURATION, HOURS | SILANE CONCENTRATION | LINER |
|---|---|---|---|
| J-01 | 54 | 20% | QUARTZ |
| J-02 | 58 | 10 - 20% | QUARTZ |
| J-03 | 72 | 15% | QUARTZ |
| K-01 | 48 | 30 - 60% | POLYSILICON |

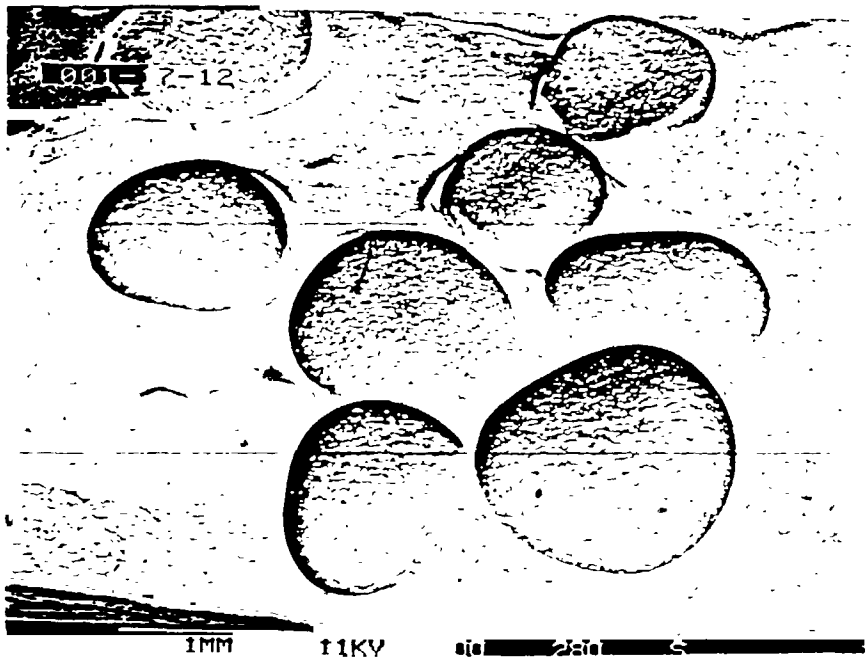
## FBR Test Run J-02 Run Summary

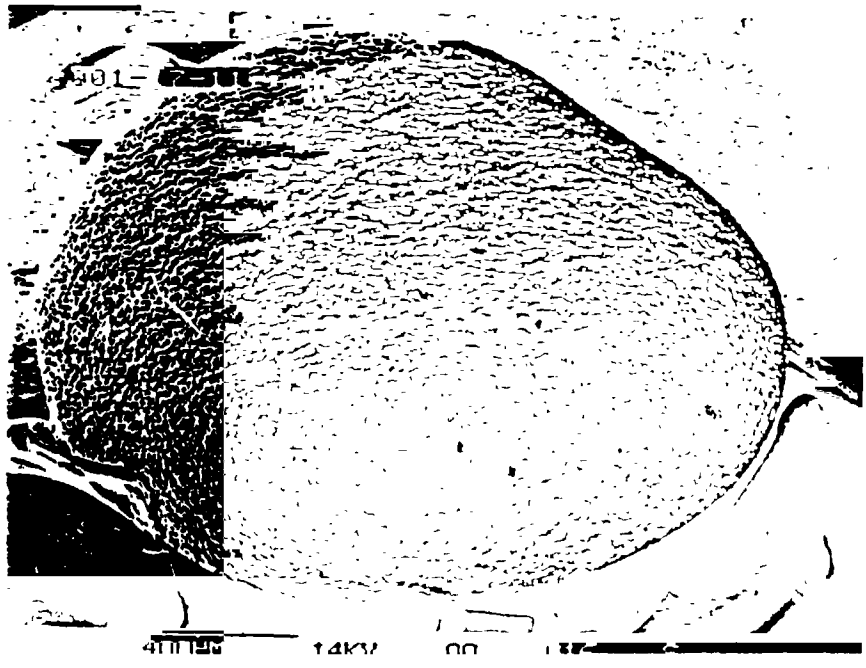
- QUARTZ LINER
- 58 HOURS DURATION
- 325 μM SEED GROWN TO 950 μM PRODUCT
- SILANE FEED RATE 2.1 KG/HR
- BED TEMPERATURE 640 - 700°C
- $U/U_{MF}$ 3.0 - 3.5
- COMPLETE SILANE CONVERSION
- 111 KG. PRODUCT WITHDRAWN
- POWDER 9%

## FBR Test Run J-02 Mass Balance

| | | | |
|---|---|---|---|
| INITIAL BED WEIGHT | | = | 15.7 KG. |
| SILICON IN | | = | 109.0 KG. |
| | TOTAL | = | 124.7 KG. |
| PRODUCT WITHDRAWN | | = | 111.2 KG. |
| POWDER IN FILTERS | | = | 11.3 KG. |
| | TOTAL | = | 122.5 KG. |
| ERROR IN MASS BALANCE | | = | 1.8 % |

## SEM Pictures of Product from Run J-02



## Seed and Product Analysis for Heavy Metals Run J-02

| ELEMENT | SEED, PPMA | PRODUCT, PPMA | |
|---|---|---|---|
| | NAA | NAA | SSMS |
| Fe | 1.6 | 0.69 | 1.0 |
| Cr | 0.35 | 0.18 | 0.05 |
| Ni | 0.11 | 0.08 | <0.05 |

## Summary of Typical FBR Product Characteristics

PARTICLE PROPERTIES

- 1000 μm DIAMETER
- 100 LB/C FT. BULK DENSITY
- SMOOTH ROUND SURFACE
- FREE FLOWING

PARTICLE MORPHOLOGY

- DENSE DEPOSITION LAYER
- LAYERED RING-LIKE GROWTH STRUCTURE
- GROWTH LAYER THICKNESS 350 μm

PARTICLE PURITY

- LOW PPB LEVELS OF BORON & PHOSPHORUS IN SINGLE CRYSTAL
- EXCELLENT POTENTIAL FOR PRODUCING SEMICONDUCTOR GRADE PURITY

## Summary of FBR Research and Development

- 6" DIAMETER FBR WAS OPERATED WITH QUARTZ & POLYSILICON LINERS.
- MANY LONG DURATION TEST RUNS WERE CONDUCTED. LONGEST CONTINUOUS RUN DURATION WAS 72 HOURS.
- FEASIBILITY OF GROWING 1000 MICRON PARTICLES BY EFFICIENT SILANE DECOMPOSITION WAS DEMONSTRATED.
- OPERATING PARAMETERS FOR STEADY STATE CONDITIONS WERE DETERMINED.
- FEASIBILITY OF MELTING FBR PRODUCT AND GROWING A HIGH RESISITIVITY DISLOCATION-FREE SINGLE CRYSTAL WAS DEMONSTRATED.
- FURTHER WORK IS REQUIRED IN THE AREA OF HIGH-PURITY SEED PREPARATION.
- FLUID BED PROCESS IS AN ESSENTIAL ROUTE FOR MEETING FSA COST GOALS.

## UCC Silane to Silicon Process Major Accomplishments

- DEVELOPMENT OF AN INTEGRATED PROCESS FOR THE PRODUCTION OF HIGH-PURITY SILANE
  - 100 MTY EPSDU
- SUCCESSFUL COMMERCIALIZATION OF UCC SILANE TECHNOLOGY
  - 1200 MTY PLANT
- DEVELOPMENT OF SILANE FLUID BED PROCESS FOR THE PRODUCTION OF LOW COST POLYSILICON
  - 6" DIA. PDU

## UCC-JPL Contract 954334 Acknowledgments


- SEVERAL UCC CONTRIBUTORS
- JPL CONTRACT MANAGERS
- DOE FINANCIAL SUPPORT

PHOTOGRAPHS OF PREVIOUS

PROJECT INTEGRATION MEETINGS

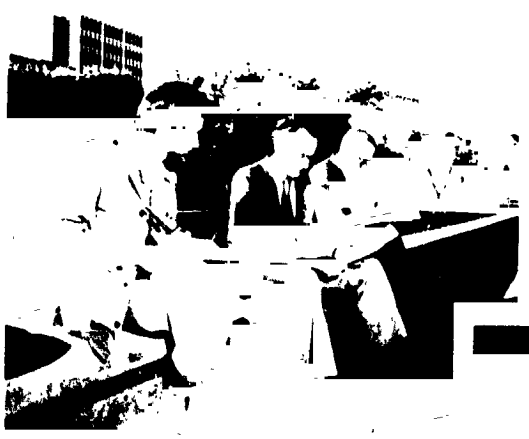















ORIGINAL PAGE IS
OF POOR QUALITY