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AMORPHOUS DIFFUSION BARRIERS

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Amorphous W-Zr Barrier

MOTIVATION

(PREVIOUS STUDIES: Ni-W, Ni-Mo, Cu-Ta)

- SUBSTITUTE Ni WITH Zr TO AVOID INTERFACIAL PENETRATION OF Ni INTO Si SUBSTRATE AT LOW TEMPERATURES (~ 400°C)

NOTE:

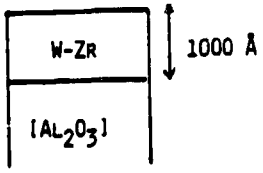
I) Ni REACTS WITH Si AT ~ 200°C

II) Ni IS THE MOVING SPECIES IN Ni+Si REACTION

III) Zr REACTS WITH Si AT ~ 700°C

IV) Si IS MOVING SPECIES IN Zr+Si REACTION

Crystallization



ANNEALED 500-900°C (30')

X-RAY

T_c ~ 900°C

Experimental

RF SPUTTER DEPOSIT W-ZR FILMS FROM A W TARGET
COVERED WITH ZR STRIPES IN 10mTORR AR
(BASE PRESURRE < 1E-6 TORR)

2 COMPOSITIONS: $W_{70}ZR_{30}$

$W_{40}ZR_{60}$

DEPOSITION RATE: ~ 400 Å / MIN

IN SITU DEPOSITION WITHOUT BREAKING VACUUM ~120 Å / MIN

ANNEALING IN VACUUM: PRESSURE < 5E-7 TORR

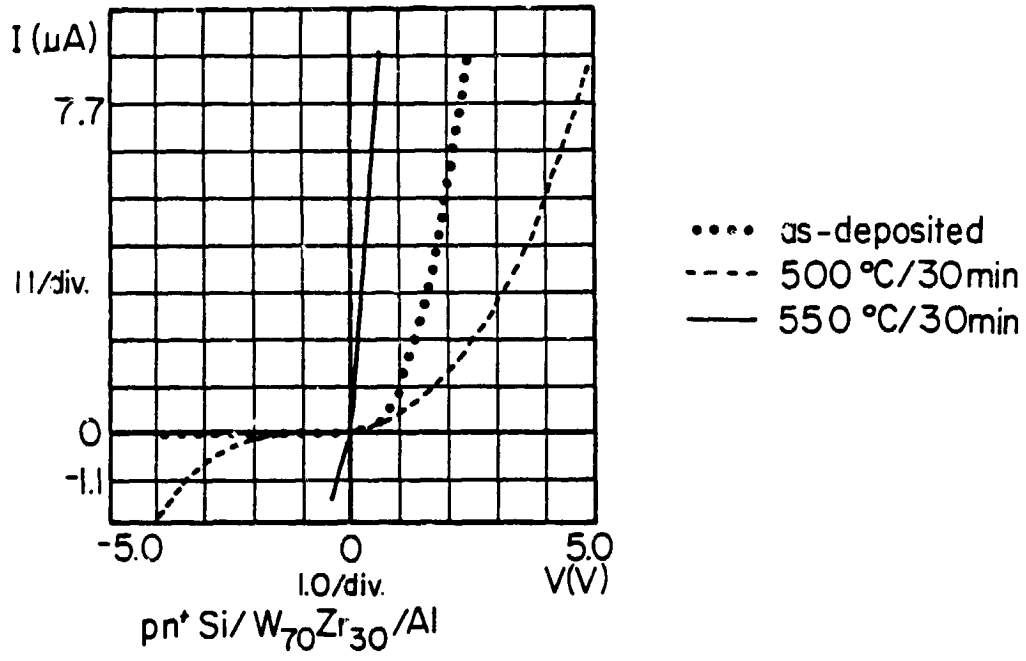
ANALYSIS:

RBS (ATOMIC DEPTH PROFILES)
SEM, EDAX (SURFACE MORPHOLOGIES)
X-RAY (PHASE IDENTIFICATION)

N^+P Shallow Junctions

JUNCTION DEPTH : 0.35 UM
JUNCTION AREA : 500 X 500 UM^2
CONTACT AREA : 300 X 300 UM^2
AS SURFACE CONCENTRATION : 3E20 CM^{-3}

I-V Characteristic of n^+p Solar Cell with W-Zr Diffusion Barrier



Behavior of W-Zr Diffusion Barrier

1) INTERDIFFUSION IN [SI]/ W-ZR / AL SETS IN AT ~ 500°C DESPITE T_c IS AS HIGH AS 900°C
(AL+W 500°C
AL+ZR 400°C)

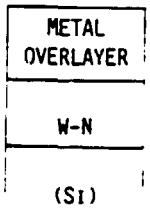
2) REACTION BETWEEN AL AND ZR-W IS LATERALLY NONUNIFORM ---PITS FORMATION

** W-ZR CANNOT BE USED AS SACRIFICIAL BARRIER

** W-ZR EFFECTIVE BELOW 500°C

W-N Barriers

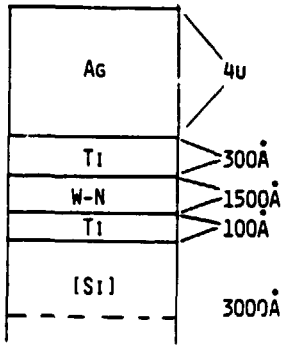
PREVIOUS WORK:



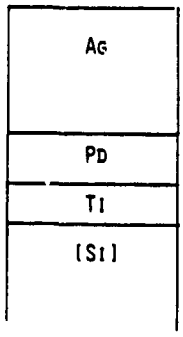
AL, Au, Ag

- W-N INHIBITS INTERDIFFUSION BETWEEN METAL OVERLAYER AND Si UP TO:
  - 550°C - 30 MIN. FOR AL
  - 800°C - 30 MIN. FOR Au
  - 700°C - 30 MIN. FOR Ag

Experimental: Solar Cell with W-N Diffusion Barrier

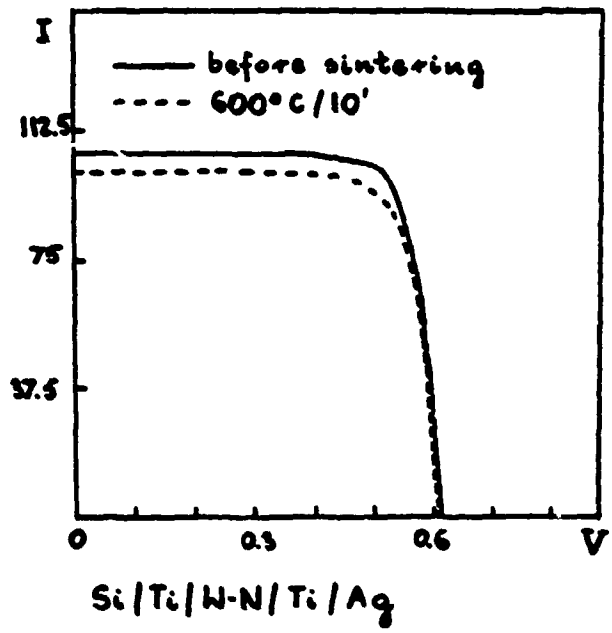


Experimental: Solar Cell with Ti-Pd-Ag Metallization

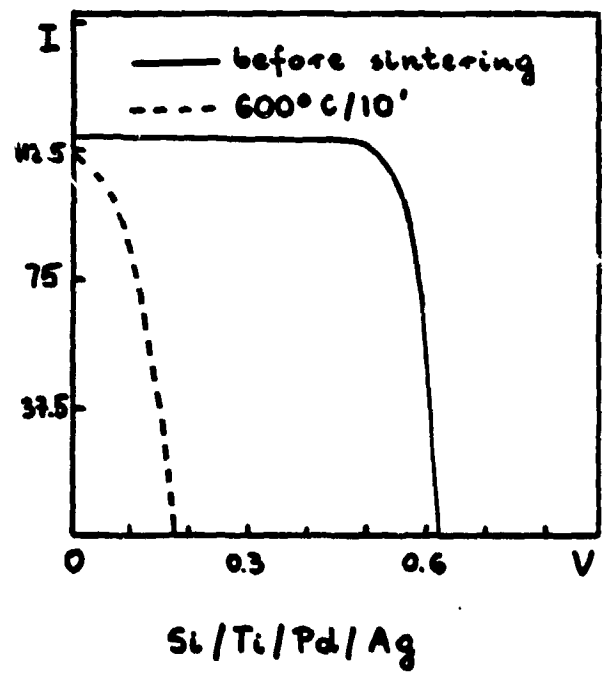


- ANNEALED IN FORMING GAS AT 400°C, 600°C FOR 10 MIN.
- I-V MEASURED UNDER AMO ILLUMINATION AT R.T.

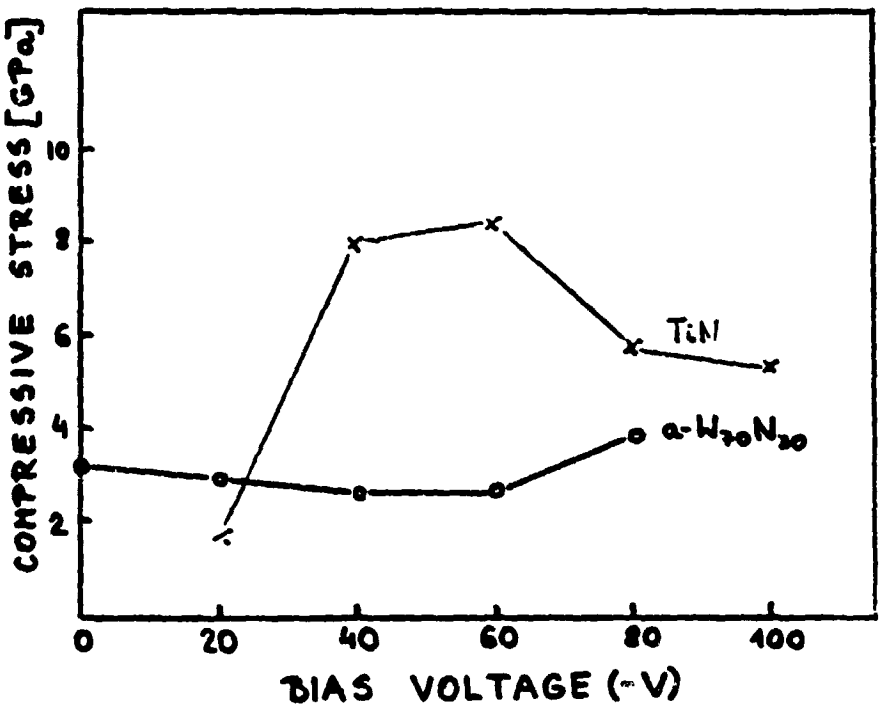
I-V Characteristic of n^+p Solar Cell with W-N Diffusion Barrier Under AM0 Illumination at Room Temperature



I-V Characteristic of n^+p Solar Cell with Ti-Pd-Ag Metallization



Comparison Between Intrinsic Stress Properties of Magnetron-Sputtered TiN and α-W-N Films



Conclusions

1) W-Zr, Ni-W, Ni-Mo
   - FAILURE MECHANISM - REACTION WITH METAL OVERLAYER BELOW T_c
   - NEED TO FIND WAYS TO SUPRESS THIS REACTION (E.G. NiNW)

2) WN
   - EFFECTIVE BARRIER BETWEEN {Al, Ag, Au} AND Si UP TO {550°C/30', 700°C/30', 800°C/30'}
   - STABLE Si/Ti/WN/Ag CONTACT TO SOLAR CELLS UP TO 600°C/10'
   - LOWER STRESS W-N FILMS CAN BE PRODUCED BY APPLYING NEGATIVE SUBSTRATE BIAS VOLTAGE