Electrodeposition of Solar Grade Silicon Films from Molten Salt

Taeho Lim, Ji Zhao, and Allen J. Bard

Why Electrodeposition of Solar Grade Silicon from Molten Salt?

- SunShot target: Si/W for utility-scale PV system by 2020
- Low production cost for solar grade silicon films via electrodeposition
- Low energy consumption of Si electrodeposition (13 kWh/kg Si), compared to conventional Siemens process (80 kWh/kg Si)

Preparation and Characterization of Electrodeposited Silicon Films

Electrodeposition of Silicon from Molten Salt

Typical Liquid Junction for p-Type Si

- Proposed Mechanism:
  - Anode: SiO + 4e → Si + 2O2
  - Cathode: C + 2O2 → CO2(g) + 4e

Characteristics of Photoactive Silicon Film

- Liquid junction formation instead of solid-state junction
- Fast and accurate test method
- Redox couple: ethyl viologen (EV2+/EV+) in acetonitrile

Effect of Impurities on Photoelectrochemical Characteristics of Photoactive Silicon Film

Secondary Ion Mass Spectroscopy Depth Profile of Electrodeposited Silicon Film

- Positive ion mode
- Negative ion mode
- Impurity Concentration after Pre-electrolysis
- Estimated dopant concentration from Mott-Schottky plot

Electrodeposition of Silicon Film from CaCl2 Molten Salt

- SiO2 nanoparticles
- Si crystallites
- Graphite substrate
- Direct reduction of SiO2 nanoparticles on graphite substrate resulting in photoactive p-type polycrystalline silicon film
- Silicon carbide (SiC) formation at silicon-graphite interface, indicating Si-C bond is formed at the initial stage of deposition, strengthening adhesion between silicon and graphite
- Some pinholes between Si crystallites exposing graphite substrate

Summary

- Photovoltaic (PV) System Pricing Trends, 2014 Ed., SunShot
- Why Electrodeposition of Solar Grade Silicon from Molten Salt?
- Preparation and Characterization of Electrodeposited Silicon Films
- Effect of Impurities on Photoelectrochemical Characteristics of Photoactive Silicon Film
- Summary

Future work

- Optimization of silicon electrodeposition process by controlling parameters such as substrate, chemical purity, current density, potential, counter electrode material, and cell configuration
- Controlling dopant of electrodeposited silicon with various dopants to construct a p-n junction by control of bath composition and/or conventional methods of p-n junction formation
- Scaling-up and fabrication of solar devices by using optimal silicon electrodeposition process in order to transfer to industry and deployment to developing countries

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