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Methods to Achieve Ultrapure Solar-Grade Silicon by Electrorefining

Background

Silicon is the most common semiconductor used in applications such as photovoltaic power generation and nanoelectronics (e.g. computer chips). These applications require a high level of material purity. Conventional refining techniques for producing high-purity silicon are highly energy intensive, requiring significant electrical and/or thermal energy inputs. For example, the Siemens method is accomplished at greater than 1000°C, and consumes up to 200 kWh of electricity for each kilogram of silicon produced. These energy demands make the refining of sufficiently high-purity silicon expensive. There is therefore a need to develop less energy-intensive, and thus cheaper, methods for the production of silicon for these applications.

Researchers at Arizona State University have developed a new electrorefining process for the production of ultrapure silicon. This process uses a two-step three-electrode approach to produce ultrapure silicon directly from metallurgical-grade silicon. It bypasses the current Siemens process, along with all of its issues such as corrosive trichlorosilane, energy intensity, and high cost. This process is effective at removing impurities from metallurgical-grade silicon, thereby resulting in silicon with ultrahigh purity better than 99.99999%. The energy input for this process is 90% lower than the Siemens method at 20 kWh for a kilogram of ultrapure silicon produced. The savings on energy alone is $10 for each kilogram of silicon.

Potential Applications

- Production of solar-grade silicon
- More energy-efficient refining of many industry metals such as aluminum and copper

Benefits and Advantages

- Significantly reduced cost
- Significantly reduced energy input
- Lower process temperature for Si production
- Ultrahigh purity materials for solar and other applications

For more information about the inventor(s) and their research, please see Meng Tao's directory webpage