Docket #: S10-129

Low-Temperature Synthesis of Polycrystalline Semiconductor Thin Films on Amorphous Substrates

Stanford researchers have patented a crystalline germanium nanostructure device and method of forming a continuous polycrystalline Ge film (5-500nm thick poly-Ge) with crystalline Ge islands of preferred orientation. A diffusion control layer between the metal and semiconductor layers allows controlled nucleation of (111)- oriented Ge crystallites on the Al seed layer. The method is suitable for Group IV and other semiconductors using a variety of metals, and their silicide and germinide compounds. The low cost, low temperature process has important applications in thin-film photovoltaic and electronics applications, such as thin-film transistors, solar cells, and flexible and large area electronics.

Stage of Research
Researchers have grown polycrystalline germanium (poly-Ge) thin films on both glass and polymer substrates at temperatures as low as 200 C. Germanium thin films with micron-size grains and (111) preferred orientation were prepared by controlled Ge nucleation and Ge lateral overgrowth of Al during *a*-Ge crystallization.

Applications

- Photovoltaics - including poly-Si, Ge, GaAs solar cells, and polycrystalline multi-junction solar cells
- Thin Film Transistors for displays, large area electronics
- Organic Semiconductors – roll-to-roll manufacturing
- Flexible substrates, RFIDs, etc.
- Low-cost alternative to crystalline Si or Ge substrates

Advantages

- Lower raw material and processing cost (~100 nm Ge thickness is thinner than existing single-or polycrystalline-bulk Ge substrates)
- Low temperature process (150-300 C)
    - Compatible with flexible and lightweight polymeric substrates as well as existing circuitry - reduces the installation cost of large area solar cells
    - Suitable for high volume manufacturing of semiconductor solar cell thin films, and favorable for high throughput roll-to-roll processes
    - Increased process reliability, and more energy efficient thermal treatment
- Preferred orientation polycrystalline thin films that can be growth templates for semiconductor nanostructures

Publications

- S. Hu, A. F. Marshall, and P. C. McIntyre, "Interface-controlled low-temperature metal-induced crystallization of germanium films on amorphous substrates," *Applied Physics Letters*, 97, 082104 (24 August 2010).
- S. Hu and P. C. McIntyre, "Metal-induced crystallization of continuous semiconductor thin films controlled by a diffusion barrier." US patent US9099411B2 (4 August 2015).

Patents

- Published Application: 20130048985
- Issued: 9,099,411 (USA)

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