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Magnesium Silicide and Germanide from Waste as a Source of CVD Precursors and Ultrapure Semiconductors

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Chemical vapour deposition (CVD) is a technology used for forming solid films of semiconductors, metals or alloys on substrate from precursor in the gas phase. Ultrapure semiconductors mainly silicon, germanium and their SiGe alloys are commonly used for production of electronic components like chips, transistors, optical parts, circuits, etc. However, a top purity is required for their application in electronic industry. Silanes ($\text{Si}_n\text{H}_{2n+2}$), germanes ($\text{Ge}_n\text{H}_{2n+2}$) and germysilanes ($\text{Si}_x\text{Ge}_y\text{H}_z$) belong to common CVD precursors applied for creation the thin semiconductor layers. Regrettably, the traditional refining methods for preparation of CVD precursors from waste Si, Ge, or SiGe are energetically and technologically demanding which is significantly reflected in their price. From that reason the newly patented process, in which waste photovoltaic panels and optical lenses served as a raw materials, was tested to be the lucrative source of silicon or germanium for CVD precursors.

The process is based on preparation of magnesium silicide (Mg_2Si), magnesium germanide (Mg_2Ge) or their mixtures directly by thermal synthesis from milled end of life photovoltaic cells and/or broken germanium lenses with waste magnesium chips. Prepared samples were characterized by X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM) with Energy Dispersive X-Ray Spectroscopy (EDX) and Raman spectroscopy, which confirmed high conversion to desired products, good crystallinity and homogeneity. The products were then hydrolysed by phosphoric acid solution to form corresponding hydrides. Fourier Transform Infrared Spectroscopy (FTIR) and Gas Chromatography–Mass Spectroscopy (GC-MS) verified that silanes and/or germanes even germysilanes were presented. The fraction distillation of individual hydrides was also successfully tested and obtained hydrides could be used either as a desired CVD precursor or as raw materials for thermal decomposition into ultrapure semiconductors (Si, Ge) and hydrogen.

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