**Preparation of Silicon and Germanium Thin Layers with High Manganese Content by Pulsed Laser Deposition.**

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# Preparation of silicon and germanium thin layers with high manganese content by pulsed laser deposition

M. Kostejn [1,2*], R. Fajgar [1], V. Drinek [1]
[1] Institute of Chemical Process Fundamentals, The Czech Academy of Sciences, Rozvojova 135, 160 00 Prague 6, Czech Republic
[2] Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University, Brehova 7, 115 19 Prague 1, Czech Republic
* The corresponding author e-mail: kostejn@icpf.cas.cz

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Silicon (Si) and germanium (Ge) with a high doping concentration of manganese (Mn) are frequently studied for their potential magnetic properties and as promising thermoelectric materials. These types of materials are referred as a possible ferromagnetic semiconductors up to the room temperature [1,2]; however, they are vulnerable to oxidization and phase separation. For deep study of these materials it is necessary to prepare stable oxygen free Si or Ge – Mn compounds.

Reactive pulsed laser deposition is a technique suitable for producing homogeneous thin layers of Si or Ge with high concentration of embedded Mn atoms. ArF excimer laser (193 nm) was used for ablation of Mn target which was held under low pressure of silane ($SiH_4$) or germane ($GeH_4$). The reaction between highly ionized ablated Mn atoms and a background gas precursor proceeds at non-equilibrium thermal condition, especially when prepared material came into contact with a substrate and temperature gradient can reach $10^4$ K $s^{-1}$ . This condition ensured homogeneous layers without Mn and Si or Ge separation.

For fast elemental analysis of thin layers, linear calibration of Energy Dispersive X ray Spectroscopy (EDS) was utilized. X-Ray Photoelectron Spectroscopy (XPS) was used in order to study the surface elemental composition and chemical states of the layers. MnSi and MnGe layers containing non oxidized Mn were obtained for Mn molar concentration in the range from 15 to 50 %. XPS measurements showed very low oxygen (O) content for MnGe layers and low O content for MnSi layers where it was bound to Si. Homogeneity and crystallization were determined by HRTEM and Raman spectroscopy. Electron diffraction showed an amorphous character of MnSi layers. MnGe layers contained two different types of nanoparticles incorporated inside an amorphous matrix.

Semiconducting properties were proved by resistivity measurement with Van der Pauw technique which showed resistivities in the range from $10^{-3}$ to $10^{-5}$ Ω m.

Reference

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