Thin Films and Coatings

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Ni_xGe_y films synthetized by LPCVD using Ge_2Me_6 and Et_3GeH precursors

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Ni_xGe_y alloys are among the candidates for Ohmic`s contacts in electronic devices since they have a low processing temperature (below 250 °C) and possess low resistivity [1,2]. Samples were prepared by Low Pressure Chemical Vapor Deposition (LPCVD) using hexamethyldigermane Ge_2Me_6 and triethylgermane Et_3GeH precursors over Ni substrate at temperature of 500 °C. Samples were characterized by SEM/EDS, XRD, TEM/EDS, and Raman spectroscopy.

Ni_xGe_y films were prepared using two different germanium containing precursors Ge_2Me_6 and Et_3GeH, and their mixture. Morphology of the resulting deposits is porous and consisting of Ge nanowires when both pure Et_3GeH and pure Ge_2Me_6 are used. Using a mixture Ge_2Me_6/Et_3GeH yields Ni_xGe_y crystals several microns in size (Figure 1) besides the porous deposit and Ge nanowires. In the direction from the input of the quartz reactor to its output, the deposits on nickel substrates changed gradually from porous to well-developed Ni_xGe_y crystals; then islands of Ge nanowires merging into a continuous cover.

According to XRD, the Ni_xGe_y crystals belong either to orthorhombic phase $Ni_{0.67}Ge_{0.33}$ (ICSD-53743) or hexagonal phase $Ni_{0.64}Ge_{0.36}$ (ICSD-87906). In addition, a modulated structure of $Ni_{19}Ge_{12}$ ($Ni_{0.61}Ge_{0.39}$) corresponding to (ICSD-53749) was observed by TEM (Figure 2). All these phases are very close in composition and it is likely that their formation is influenced by the diffusivity of Ni from the substrate.

1. J. H. Park, P. Kapur, K. C. Saraswat, H. Peng, Appl. Phys. Lett. 91 (2007), p. 143107-1.
2. X. V. Li, M. K. Husain, M. Kiziriglou, C. H. de Groot, Microelectron. Eng. 86 (2009), p. 1599.
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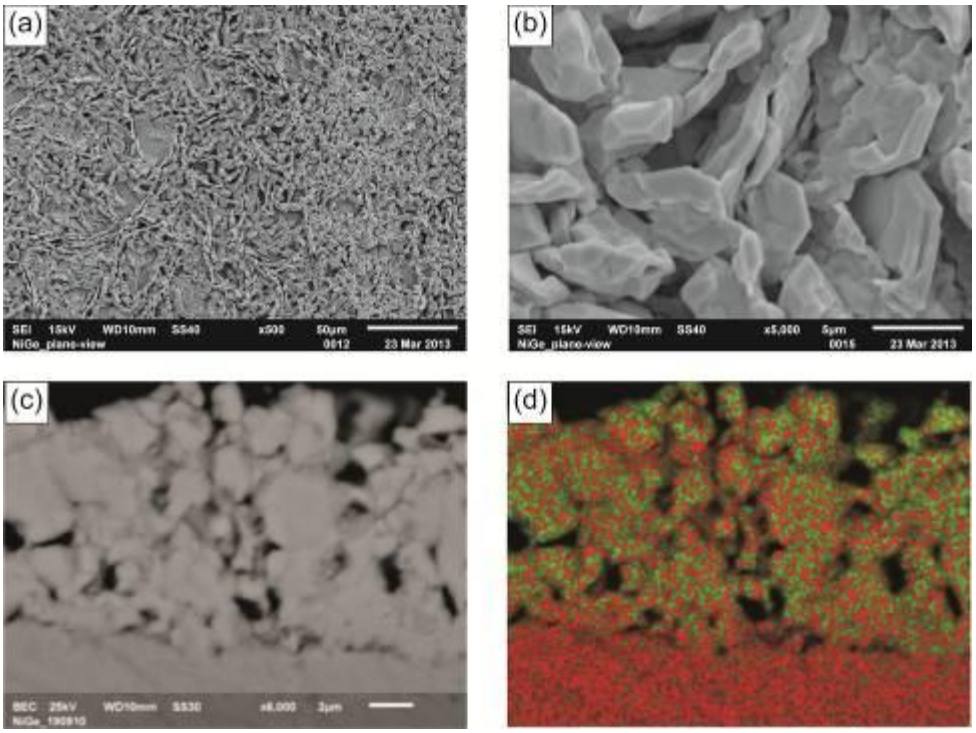

Figure 1. SEM observations of the deposit: (a), (b) plane view, (c) cross-section in BSE, (d) EDS mapping of the area shown in (c) - red - nickel, green - germanium.

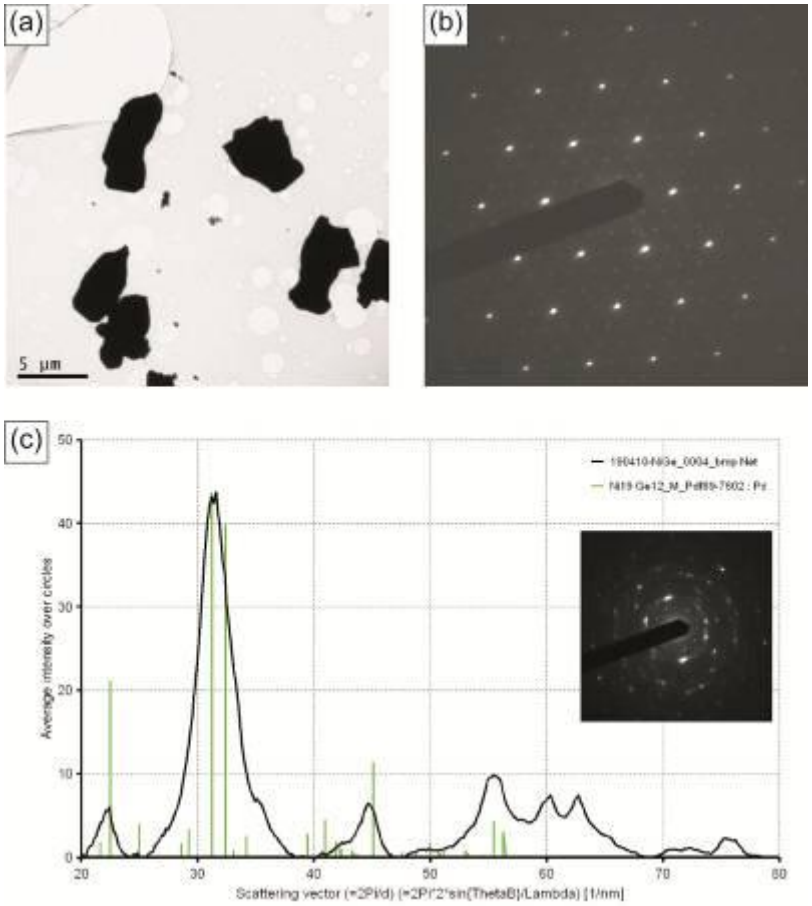

Figure 2. TEM observations of the deposit: (a) low-mag image, (b) SAED corresponding to $Ni_{19}Ge_{12}$ single crystal, (c) SAED corresponding to powder $Ni_{19}Ge_{12}$.