Methods for Forming Composites with 2D Structures

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BACKGROUND

Currently, thin films of single-crystalline (SC) alloy material are obtained using costly SC substrates made of a material chemically and physically compatible to that of a SC thin film that is deposited on the SC substrate. Formation of SC thin films of alloy materials on SC substrates are typically achieved through fairly expensive processes such as epitaxy. As a result, the use of a thin film of SC alloy materials or respective multiple thin films is contingent upon the availability of an appropriate SC substrate thereby severely limiting its utilization. Thus, there is a need for alternative methods of forming one or more thin films of SC alloy materials on arbitrary substrates. Crystallization of thin film materials by exploiting laser-induced crystallization has been advancing for the past four decades. This unique thin film technique has been predominantly used in processing thin film materials made of a single chemical element, with a significant emphasis on thin film materials comprised of a single chemical element like silicon (Si), used for the development of thin film transistors. While this approach has worked well for thin film materials comprised of a single chemical element like silicon (Si) it is not easily extended for use with thin film materials containing multiple chemical elements (e.g., metal oxides). For certain bulk manufacturing applications, it would be desirable to efficiently form thin structures on non-single-crystalline (NSC) substrates, such as glass, or on SC substrates that are highly-incompatible, such as silicon. For such applications, it is highly desirable that the treated SC alloy layer(s) have chemical compositions not significantly different from those of their original chemical compositions.

TECHNOLOGY DESCRIPTION

To address these challenges, researchers at UC Santa Cruz (UCSC) have developed cost-effective methods of forming composites having a two-dimensional (2D) structure that includes one or more thin films. The structure is formed from NSC alloy materials on a NSC substrate. Each of the NSC alloy materials has a specific chemical composition associated with, for instance, its cations and/or anions. A part of the 2D structure is crystallized and forms SCs as the material undergoes melting at an elevated temperature and subsequent solidification upon cooling. The resulting 2D structure on NSC substrate includes one or more thin films made of SC alloy materials that have chemical compositions not significantly different from those of their original chemical compositions. The UCSC methods also enable thin film(s) of SC alloy materials (e.g., Group III-V compound semiconductors) to be formed on mismatched substrates comprising NSC or SC materials.

APPLICATIONS

- semiconductor devices

ADVANTAGES

- cost-effective as compared to epitaxy
- high materials versatility for films and substrate
- leverages industry-standard workflow

INTELLECTUAL PROPERTY INFORMATION

Country	Type	Number	Dated	Case
United States Of America	Published Application	20220316086	10/06/2022	2020-255
United States Of America	Published Application	20210043451	02/11/2021	2020-255

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OTHER INFORMATION

KEYWORDS

thin films, thin film, single-crystal, single-crystalline, epitaxy, non-single-crystalline, non-single-crystal, two-dimensional, 2D, semiconductor, thin film transistors, photovoltaics

CATEGORIZED AS

- **Materials & Chemicals**
  - Composites
  - Thin Films
- **Semiconductors**
  - Design and Fabrication
  - Materials

RELATED CASES

2020-255-0

RELATED MATERIALS

- Laser-induced crystallization of copper oxide thin films: A comparison made between Gaussian and chevron-beam profiles provides a clue for the failure of Gaussian-beam profile - 05/24/2022
- Formation of single-crystal Cu2O strips in non-single-crystal CuO thin films by continuous-wave laser diode with micro-chevron laser beam (u-CLB) - 07/16/2020

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