nanomaterials

MDPI

Editorial

Editorial for the Special Issue on "10th Anniversary of Nanomaterials—Recent Advances in Nanocomposite Thin Films and 2D Materials"

Jordi Sort [1,2,*] and Gemma Rius [3]

[1] Departament de Física, Universitat Autònoma de Barcelona (UAB), E-08193 Cerdanyola Del Vallès, Spain
[2] Institució Catalana de Recerca i Estudis Avançats (ICREA), Pg. Lluís Companys 23, E-08010 Barcelona, Spain
[3] Instituto de Microelectrónica de Barcelona (IMB-CNM, CSIC), Campus UAB, E-08193 Cerdanyola del Vallès, Spain; gemma.rius@csic.es
* Correspondence: Jordi.Sort@uab.cat

As a way to celebrate the 10th anniversary of the journal Nanomaterials, this Special Issue within the section 'Nanocomposite thin film and 2D materials' provides an overview of the wide spectrum of research challenges and applications in the field, represented by a collection of 12 contributions, including three up-to-date review articles plus nine original works, in different targeted topics as described below.

The importance of synthesis and processing in the properties of compound or alloy thin films and their applications as functional coatings is reported in three of the contributed articles. Such is the case for perovskite $BiFeO_3$ films presented by Micard et al. [1]). They use metal organic chemical vapor deposition (MOCVD) to optimize polycrystalline, pure phase thin films, as understood from XRD, EDX, and FE-SEM characterizations. Films piezoelectricity and ferroelectric property is confirmed by piezo force microscopy and spectroscopy, which envisions their use as lead-free hybrid energy harvesters. Another synthesis work is presented by Sudiyarmanto and Kondoh in [2]. In this case, supercritical fluid chemical deposition is applied to the production of Ni-Pt alloy thin films. By tuning the deposition rate with the precursors ratio, they obtain, as well, single-phase, polycrystalline material of the Ni-Pt alloy. The films are intended to be used as model catalyst surfaces due to their high activity and stability. In [3], the relevance of amorphous films is exemplified in contribution of Yan et al., in which a processing development on Mg-based metallic glasses for improving the corrosion resistance is presented. Particularly, first, MgO nanoplate arrays are coated by cyclic voltammetry treatments, and then, stearic acid is efficiently adhered to their surface, so that the corrosion resistance to NaCl solution is increased.

The versatility and flexibility of the growing and continuously evolving family of 2D materials is also well represented in this Special Issue. The advances in graphene materials are still generating new knowledge while still requiring significant technological progress. Novel methods to obtain graphene–polymer composite films with multiple functionalities, or their use for sensing platforms are two examples.

Van der Schueren et al. [4] show how co-mixing aqueous colloids plus casting of PVA and few-layer graphene can be used to obtain composite films with multiple functional properties. As their exfoliation method provided relatively large graphene flakes, the PVA-FLG composite exhibits good mechanical and electrical conductivity characteristics, as well as potential as an O_2 barrier membrane based on a transmission rate reduction of 60%. In another contributed paper [5], graphene is used to realize interference-enhanced Raman scattering. Here, the key is to combine single-layer graphene with an ultra-thin alumina film on top of a metallic aluminum support. Correlating both experimental and theoretical results, their interference amplification can also be implemented. With this platform, on the basis of more conventional SERS, good results were obtained by simply adding ultra-small silver particles.

check for updates

Citation: Sort, J.; Rius, G. Editorial for the Special Issue on "10th Anniversary of Nanomaterials—Recent Advances in Nanocomposite Thin Films and 2D Materials". *Nanomaterials* **2021**, *11*, 2069. https://doi.org/10.3390/nano11082069

Received: 4 August 2021
Accepted: 11 August 2021
Published: 15 August 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Closely related to the relevant and relatively new graphene and composites investigations domain, families of emerging materials such as 2D carbides and nitrides (MXene) and transistion metal dichalcogenides (TMD) are also receiving lots of attention and are thus represented in this Special Issue. The paper by Raagulan et al. [6] reviews reported works on MXene–graphene aerogel composites, with the focus on their use as electromagnetic interference shielding materials. Their efficiency is correlated with the obtained morpho-structural characteristics, while they compile relevant information in terms of processing techniques. In addition, centered on the specific functionalities of MXene materials, another review is provided by Ibrahim et al. [7] on their application for supercapacitors. In particular, they summarize the current knowledge and assess the progress in the self-standing MXenes as understood from their mechanical properties analysis and comparison to hybrid MXenes or other 2D materials.

Finding energy solutions in nanomaterials and, particularly, exploiting higher efficiencies derived from intrinsically high and, for instance, electrochemically-active, surface area of 2D materials has been an intense quest in the field. The original work provided by Hussain et al. [8] is a good example of the opportunities to investigate combinations of emerging materials and new synthetic processes. They develop a simple, one-pot, chemical reaction to produce hybrid W_2C/WS_2 nanostructured electrodes, which show good electrochemical performances for energy applications, such as hydrogen evolution and supercapacitors.

Another demonstration of the new developments needed for nanostructured, emergent 2D materials is given by Li et al. in [9]. In this case, they aim to facilitate integration toward industry by providing automated software methods and hyperspectral imaging hardware for characterizing MoS_2 materials. Their convolutional neural-network-based algorithms demonstrated identification capabilities with a special resolution down to 100 nm and reasonable acquisition times in relatively large images.

Concluding, nanomaterials combinations including structural carbon films have a long run and will be the object of many research studies and developments in view of their commercial adoption. Versatile, abundant carbon, engineered at the nanoscale, still brings advances such as reflected in the following three papers, two of them about original developments of functional films or coatings and a concise review on RRAM devices.

Zhang et al. [10] combine carbon nitride films with TiO_2 to obtain visible light enhanced photocatalysis, where the key of its efficiency comes from the optimization of plasma processing gases, while Sharma et al. [11] also use ion-based methods and study the synthesis of Li-C nanocomposites to evaluate their material potential for alternative batteries, such as based on Li–air interfaces. A comprehensive review on RRAM resistive switching mechanisms, materials, and bionic synaptic application is provided by Shen et al. [12] as a good example of the central role of nanomaterials in enabling sustainable and efficient solutions to current and future demands of our society.

Funding: This research was funded by the *Agencia Estatal de Investigación* of the Spanish Government (Grant Nos. MAT2017-86357-C3-1-R, PID2019-104670GB-I00 and associated FEDER, and RYC-2016-21412), and the Generalitat de Catalunya (Grant Nos. 2017-SGR-292 and 2017-SGR-105).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Micard, Q.; Condorelli, G.G.; Malandrino, G. Piezoelectric BiFeO3 thin films: Optimization of MOCVD process on Si. *Nanomaterials* **2020**, *10*, 603. [CrossRef] [PubMed]
2. Sudiyarmanto; Kondoh, E. Synthesis and characterization of Ni-Pt alloy thin films prepared by supercritical fluid chemical deposition technique. *Nanomaterials* **2021**, *11*, 151. [CrossRef] [PubMed]
3. Yan, Y.; Liu, X.; Xiong, H.; Zhou, J.; Yu, H.; Qin, C.; Wang, Z. Stearic Acid Coated MgO Nanoplate Arrays as Effective Hydrophobic Films for Improving Corrosion Resistance of Mg-Based Metallic Glasses. *Nanomaterials* **2020**, *10*, 947. [CrossRef] [PubMed]
4. Van der Schueren, B.; El Marouazi, H.; Mohanty, A.; Lévêque, P.; Sutter, C.; Romero, T.; Janowska, I. Polyvinyl alcohol-few layer graphene composite films prepared from aqueous colloids. Investigations of mechanical, conductive and gas barrier properties. *Nanomaterials* **2020**, *10*, 858. [CrossRef] [PubMed]

5. Aguilar-Pujol, M.; Ramírez-Jiménez, R.; Xifre-Perez, E.; Cortijo-Campos, S.; Bartolomé, J.; Marsal, L.; de Andrés, A. Supported ultra-thin alumina membranes with graphene as efficient interference enhanced raman scattering platforms for sensing. *Nanomaterials* **2020**, *10*, 830. [CrossRef] [PubMed]
6. Raagulan, K.; Kim, B.M.; Chai, K.Y. Recent advancement of electromagnetic interference (EMI) shielding of two dimensional (2D) MXene and graphene aerogel composites. *Nanomaterials* **2020**, *10*, 702. [CrossRef] [PubMed]
7. Ibrahim, Y.; Mohamed, A.; AbdelGawad, A.M.; Eid, K.; Abdullah, A.M.; Elzatahry, A. The recent advances in the mechanical properties of self-standing two-dimensional MXene-based nanostructures: Deep insights into the supercapacitor. *Nanomaterials* **2020**, *10*, 1916. [CrossRef] [PubMed]
8. Hussain, S.; Rabani, I.; Vikraman, D.; Feroze, A.; Ali, M.; Seo, Y.-S.; Kim, H.-S.; Chun, S.-H.; Jung, J. One-pot synthesis of W_2C/WS_2 hybrid nanostructures for improved hydrogen evolution reactions and supercapacitors. *Nanomaterials* **2020**, *10*, 1597. [CrossRef] [PubMed]
9. Li, K.-C.; Lu, M.-Y.; Nguyen, H.T.; Feng, S.-W.; Artemkina, S.B.; Fedorov, V.E.; Wang, H.-C. Intelligent identification of MoS2 nanostructures with hyperspectral imaging by 3D-CNN. *Nanomaterials* **2020**, *10*, 1161. [CrossRef] [PubMed]
10. Zhang, B.; Peng, X.; Wang, Z. Noble metal-free TiO2-coated carbon nitride layers for enhanced visible light-driven photocatalysis. *Nanomaterials* **2020**, *10*, 805. [CrossRef] [PubMed]
11. Sharma, S.; Osugi, T.; Elnobi, S.; Ozeki, S.; Jaisi, B.P.; Kalita, G.; Capiglia, C.; Tanemura, M. Synthesis and characterization of Li-C nanocomposite for easy and safe handling. *Nanomaterials* **2020**, *10*, 1483. [CrossRef] [PubMed]
12. Shen, Z.; Zhao, C.; Qi, Y.; Xu, W.; Liu, Y.; Mitrovic, I.Z.; Yang, L.; Zhao, C. Advances of RRAM devices: Resistive switching mechanisms, materials and bionic synaptic application. *Nanomaterials* **2020**, *10*, 1437. [CrossRef] [PubMed]