

Review

Plasmon Inspired 2D Carbon Nitrides: Structural, Optical and Surface Characteristics for Improved Biomedical Applications

Amel Gacem ¹, Suriyaprabha Rajendran ^{2,*}, Mohd Abul Hasan ³, Shakti Devi Kakodiya ⁴, Shreya Modi ⁵, Krishna Kumar Yadav ⁶, Nasser S Awwad ⁷, Saiful Islam ³, Sungmin Park ⁸ and Byong-Hun Jeon ^{9,*}

¹ Department of Physics, Faculty of Sciences, University 20 Août 1955, Skikda 21000, Algeria

² School of Nanosciences, Central University of Gujarat, Gandhinagar 382030, India

³ Civil Engineering Department, College of Engineering, King Khalid University, Abha 61421, Saudi Arabia

⁴ School of Bioscience, Rani Durgavati Vishwavidyalaya, Jabalpur 482001, India

⁵ Department of Microbiology, Shri Sarvajani Science College, Mehsana 384001, India

⁶ Faculty of Science and Technology, Madhyanchal Professional University, Ratibad 462044, India

⁷ Department of Chemistry, King Khalid University, P.O. Box 9004, Abha 61413, Saudi Arabia

⁸ Department of Civil and Environmental Engineering, Hanyang University, 222-Wangsimni-ro, Seongdong-gu, Seoul 04763, Korea

⁹ Department of Earth Resources & Environmental Engineering, Hanyang University, 222-Wangsimni-ro, Seongdong-gu, Seoul 04763, Korea

* Correspondence: sooriyarajendran@gmail.com (S.R.); bhjeon@hanyang.ac.kr (B.-H.J.)

Abstract: In the past few years, noble metal-based 2D nanomaterials particularly Ag and Au enriched carbon nitrides have seen advanced catalytic actions and reactivity. These composite nanostructures' chemical and physical characteristics have been applied to improve the targeted functionalities in healthcare and medical sciences. Many scientists and experts were inspired to study their foundational technologies in the medicinal industries via architectural and surface modifications by doping of noble nanoparticles. Here, we have provided fundamental ideas for structuring Ag and Au decorated CNs (carbon nitrides) by studying their morphological and modified surface properties for biomedical applications. There is a vast spectrum of publications that discusses the peculiarities of CNs and noble metal's key discoveries. The impact of surface plasmons resonance (SPR) is an essential factor for noble metals and that is why it is focused extensively for better performance in biomedical sectors. The elemental combinations on the CNs surfaces and their morphological status were found to be much more efficient which is broadly discussed. The fabrication techniques, structural characterizations, and SPR role of Ag and Au are addressed including fundamental concepts followed by many suitable examples under this review.

Keywords: carbon nitrides; nanoparticles; noble metals; structural characteristics; biomedical uses



Citation: Gacem, A.; Rajendran, S.; Hasan, M.A.; Kakodiya, S.D.; Modi, S.; Yadav, K.K.; Awwad, N.S.; Islam, S.; Park, S.; Jeon, B.-H. Plasmon Inspired 2D Carbon Nitrides: Structural, Optical and Surface Characteristics for Improved Biomedical Applications. *Crystals* **2022**, *12*, 1213. <https://doi.org/10.3390/cryst12091213>

Academic Editor: Giancarlo Salviati

Received: 14 July 2022

Accepted: 22 August 2022

Published: 28 August 2022

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



Copyright: © 2022 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/>).

1. Introduction

Unique electromagnetic and physicochemical functionalities of conductive nanostructures along with suitable polymeric frameworks have been employed as a multifunctional tool in the field of nanoscience and technologies range for a variety of applications, including photovoltaic, therapeutic, and photocatalyst. [1–3]. Noble metals in the class of metallic nanostructures were used as individual and also as co-doped ions to enhance the work quality and efficiency. Several inorganic nanoparticles (NPs) such as Pt, Pd, Ag, and Au have been appreciated due to their surface plasmon properties in materials research and nanoelectronics. The most studied metals are Ag and Au nanostructures which have distinctive photonic excitation regions in the electromagnetic spectrum due to their specific conduction bands electrons and nano range sizes. These optical and electronic characteristics provide an outstanding catalytic action against targeted applications. [4,5]. The associated electronic configurations of both the Ag and Au NPs found much better as