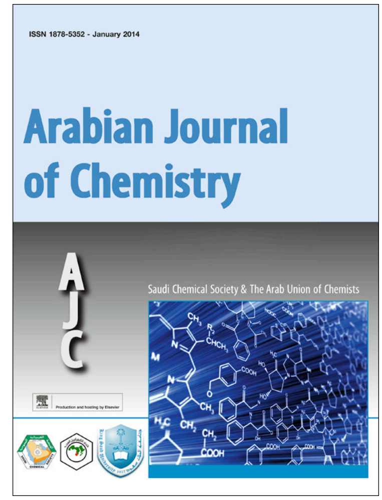
Accepted Manuscript



Original article

Unveiling an unexpected potential of beetroot waste in green synthesis of single crystalline gold nanoplates: A mechanistic study

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PII: S1878-5352(18)30074-1
DOI: https://doi.org/10.1016/j.arabjc.2018.03.016
Reference: ARABJC 2285

To appear in: *Arabian Journal of Chemistry*

Received Date: 23 February 2018
Accepted Date: 24 March 2018

Please cite this article as: G.K. Deokar, A.G. Ingale, Unveiling an unexpected potential of beetroot waste in green synthesis of single crystalline gold nanoplates: A mechanistic study, *Arabian Journal of Chemistry* (2018), doi: https://doi.org/10.1016/j.arabjc.2018.03.016

Title: - Unveiling an unexpected potential of beetroot waste in green synthesis of single crystalline gold nanoplates: A mechanistic study

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Abstract

A novel green synthetic route developed toward unveiling a mechanism of formation of single crystalline gold (Au) nanoplates, with a flat surface using an aqueous extract of red beetroot waste (BRW) i.e peel, at room temperature, the first time. The green method monitored using UV-VIS spectrophotometry, the presence of metallic gold, its structure; orientation and the responsible biomolecules; for reduction validated using EDS, XPS, XRD and FTIR spectroscopies respectively. Based on these significant characterizations, a probable three-step mechanism proposed here for nanoplate synthesis. First, the synthesis of the nanosphere, second its transformation into icosahedrons and ultimately its fragmentation into triangular nanoplates. The green synthetic mechanism for these nanoplates is investigated, validated and evidenced by both HR-TEM and XRD studies. The selected area electron diffraction (SAED) patterns and the assessment of Moire´ fringes confirmed that the nanoplates formed in this manner found single crystalline efficiently oriented in {111} lattice plane as their basal planes.

Keywords: Green synthesis; gold nanoplates; mechanistic study; single crystalline; beetroot; waste; PRODUCTIVELY; Triangular; X-ray photon spectroscopy (XPS); HR-TEM

1. Introduction

Since the dawn of nanoscience, metal nanoparticles have achieved massive interest because of their distinctive properties. Au nanomaterials show wide applications in multiple fields due to their excellent catalytic activity and biocompatibility, non-toxicity and offer a favourable environment for biomolecules (Rosi and Mirkin, 2005; Schmid, 1992). The last few years have witnessed remarkable advancement by gaining the significant attention in the synthesis of a variety of metal nanostructures due to their distinctive physical and chemical properties. These are clearly dissimilar with their bulk solid, and widely used in catalysis (Yin et al., 2011), Photonics (Sardar et al., 2009), biosensing (Pingarrón et al., 2008), electronics (Jeong et al., 2008) and nanomedicines (Chen et al., 2007). The range of methods for variety of structures includes nanocrystals (Hao et al., 2004), nanorods, nanocubes, nanowires, nanoplates, nanoclusters, nanobelts (Beeram and Zamborini, 2010; Osberg et al., 2012; Payne et al., 2014; Tsung et al., 2006) and so on. Besides the variety of morphologies, nanoplates of gold achieved noticeable interest due to their superior localized surface plasmon resonance (LSPR) properties having distinct dipolar and quadrupolar plasmon resonances consigned from their sharp corners and edges. Additionally, plate-like nanostructures exhibit higher surface to bulk atom's ratio than other nanostructures and provide wide applications in nanodevices, bio-imaging and surface-enhanced Raman scattering (SERS), electrochemical sensing (Deckert-