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# Boron doped RGO from discharged dry cells decorated Niobium pentoxide for enhanced visible light-induced hydrogen evolution and water decontamination

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ABSTRACT

Upgradation in technology leads to the accumulation of a large amount of electronic waste and causes serious issues in the environment. Discharged dry cells are one such waste that needs proper monitoring. The present work deals with the synthesis of boron-doped reduced graphene oxide (BRGO) from graphite derived from dry cells. $Nb_2O_5$ (NbO) nanoflakes were decorated with BRGO. Structural and morphological characterizations confirm the formation of NbO-BRGO. NbO-BRGO showed enhanced photocatalysis compared to pristine BRGO and NbO. The photocatalytic $H_2$ evolution was found to be 1742, 1216 and 855 μmol in the presence of NbO-BRGO, NbO and BRGO, respectively. The effect of sacrificial agents was studied and found TEOA to exhibit the highest activity. NbO-NBRO was further evaluated for the degradation of crystal violet (CV) dye under different light sources and was found to degrade 97.6 % under solar light. The reaction conditions like the effect of pH, catalyst dosage, and initial concentration were optimized carefully. The optical, electronic and photoelectrochemical characterizations of the materials indicate the decreased bandgap (2.70 eV), enhanced separation of photoexcited electrons and holes and superior current response in NbO-BRGO. The mechanism of photocatalysis has been predicted from LC-MS analysis insights. The NbO-BRGO exhibit good stability in the experiments performed under the light. The results indicate the suitability of the NbO-BRGO material for light-driven catalytic activity for energy production and environmental remediation.

## 1. Introduction

An enormous amount of issues are associated with energy deficiency and environmental pollution that is closely related to human beings. Energy production from renewable sources exhibits twin advantages; one is to meet the energy demand and the second is reducing environmental issues [1,2]. Therefore, materials that serve towards energy production and solve environmental problems are in high demand due to their effective impact on the ecosystem [3,4]. Semiconductor photocatalysis is one of the prominent methods to resolve existing energy and environmental issues. Designing visible light active catalysts is gaining much attention involving the conversion of solar energy into chemical energy to evolve hydrogen and pollutant removal from aqueous media. The key goal in fabricating visible light active catalysts is to monitor the bandgap, surface area, wide light absorption ability, separation of photoinduced electron-hole pair, stability etc [5–8].

Hydrogen is clean and environment friendly that can replace fossil fuels soon. At present $H_2$ is produced through steam reformation phenomena at elevated temperatures from natural gas and another is by using noble metals like Pt, Pd and Ru [9,10]. These methods usually suffer from low efficiency, high cost, and low chemical kinetics. Hence the materials free from noble metals, economical and easy to synthesize are the challenges taken up by the researchers universally [11,12]. Environmental pollution is another global issue considered as one of the

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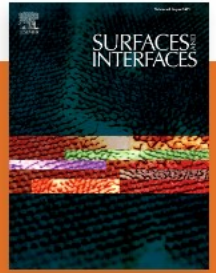


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