

## Single Nanoparticle (Photo) Electrochemistry

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### Abstract

One of the most important disciplines that contribute to the creation of more sustainable economies is electrochemistry. It is critical for energy conversion and storage, sensing, and a variety of other scientific and technological sectors.

Traditional electrochemical techniques have been used to investigate electrochemical systems. The utilisation of *in situ* techniques and computational studies, on the other hand, has aided in understanding the relationships between nanoparticle size/shape/composition and their activity/stability.

**Keywords:** Nanoparticle; Photoelectrochemistry; Electrocatalysis

### Introduction

Despite significant advancements, most measurements are carried out simultaneously on a large number of nanoparticles, making it difficult to grasp the fundamental relationship between the properties of a group of nanoparticles (ensemble) of varying size, shape, and composition and the measured activities and stabilities. In this regard, characterisation and measurement of individual nanoparticle activity and stability are emerging as a promising way to bridge the gap between nanomaterial physicochemical qualities and their performance in (photo) electrochemical processes, allowing for rational material design.

The goal of this collection is to highlight high-quality investigations of individual nanoparticle activity and/or stability in the disciplines of electrochemical energy conversion and storage, electro catalysis, and other related fields. Manuscripts on novel advancements in instrumentation, theory, and experiment involving individual nanoparticles are welcome to be submitted to the collection.

Nano particle photoelectron chemistry is an intriguing topic that studies the chemistry and physics of photo driven reactions at solid-liquid interfaces. The interdisciplinary area brings together (electro) engineers, materials scientists, spectroscopists, and theorists to investigate fundamental and application issues such carrier dynamics at lighted electrode interfaces and solar energy conversion to electricity or chemical fuels.

The first observation of a photovoltaic effect at an illuminated silver chloride electrode was made by French physicist Edmond Becquerel in 1839. Brattain and Garrett demonstrated how the electronic characteristics of n- and p-type germanium electrodes were linked to the speeds of chemical reactions under dark and light conditions over a century later.

A space charge zone is the positively charged region in the solid and the negatively charged region at the solid/liquid contact. If all electrons transfer from dopant atoms in the solid, the charge equilibration process leaves an area of positively charged dopant atoms stationary at the semiconductor/electrolyte interface. Basic principles and underlying processes in

photoelectrochemistry. A semiconductor/electrolyte interface before and after contact. An electric field region forms after contact, and band bending occurs within the semiconductor. For large-area, low-cost photoelectrodes, nanomaterials are appealing possibilities. For example, high throughput deposition technologies like roll-to-roll manufacturing might be used to deposit affordable, solution-processed nanoparticle inks on flexible substrates. The behaviour of nano particle electrodes differs from that of bulk electrodes. The space charge area at the nanoparticle/electrolyte interface is a major contributor to the varied photoelectrochemical behaviour. Charge separation/transport and interfacial charge transfer could be influenced by the nanoparticle's atomic structure in the following ways. The size and direction of the internal electric field that drives charge separation and transport can be strongly influenced by the specific placements of impurity dopant atoms in the nanoparticle core.