# Advances in the Reduction of the Costs Inherent to Fossil Fuel Biodesulfurization Towards Its Potential Industrial Applications

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**4 authors:**

Susana M Paixão
Laboratório Nacional de Energia e Geologia
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Tiago P. Silva
Laboratório Nacional de Energia e Geologia
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Bruno Firmino Arez
Laboratório Nacional de Energia e Geologia
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Luís Alves
Laboratório Nacional de Energia e Geologia
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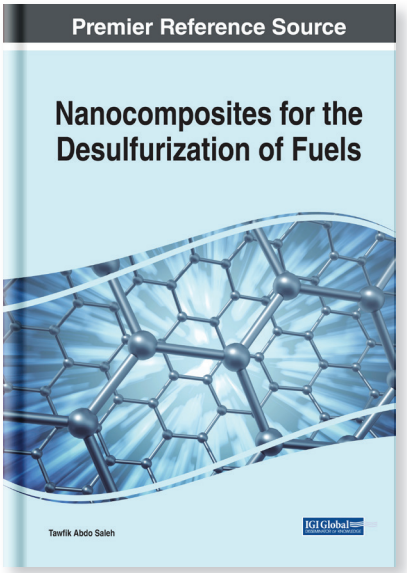
# Nanocomposites for the Desulfurization of Fuels

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## Description:

Research on nanotechnology has mainly focused on the aspects of synthesis of nanomaterials that have unique chemical, thermal, and mechanical properties applicable to a wide range of applications. A variety of properties and phenomena have been investigated, and many of the studies have been directed toward understanding the properties and applications of nanomaterials. Nanomaterials have properties that are useful for enhancing surface-to-volume ratio, reactivity, strength, and durability. Due to their enhanced chemical and mechanical properties, the nanomaterials play promising roles in enhancing the desulfurization.

**Nanocomposites for the Desulfurization of Fuels** is an essential reference source that discusses the synthesis, properties, and technological developments of nanomaterials and their applications in petroleum. Featuring research on topics such as hybrid materials, catalytic properties, and environmental concerns, this book is ideally designed for chemical engineers, scientists, researchers, academicians, and students in fields that include chemistry, petroleum, materials science, physics, and engineering.

**ISBN:** 9781799821465 **Release Date:** November, 2019 **Copyright:** 2020 **Pages:** 300

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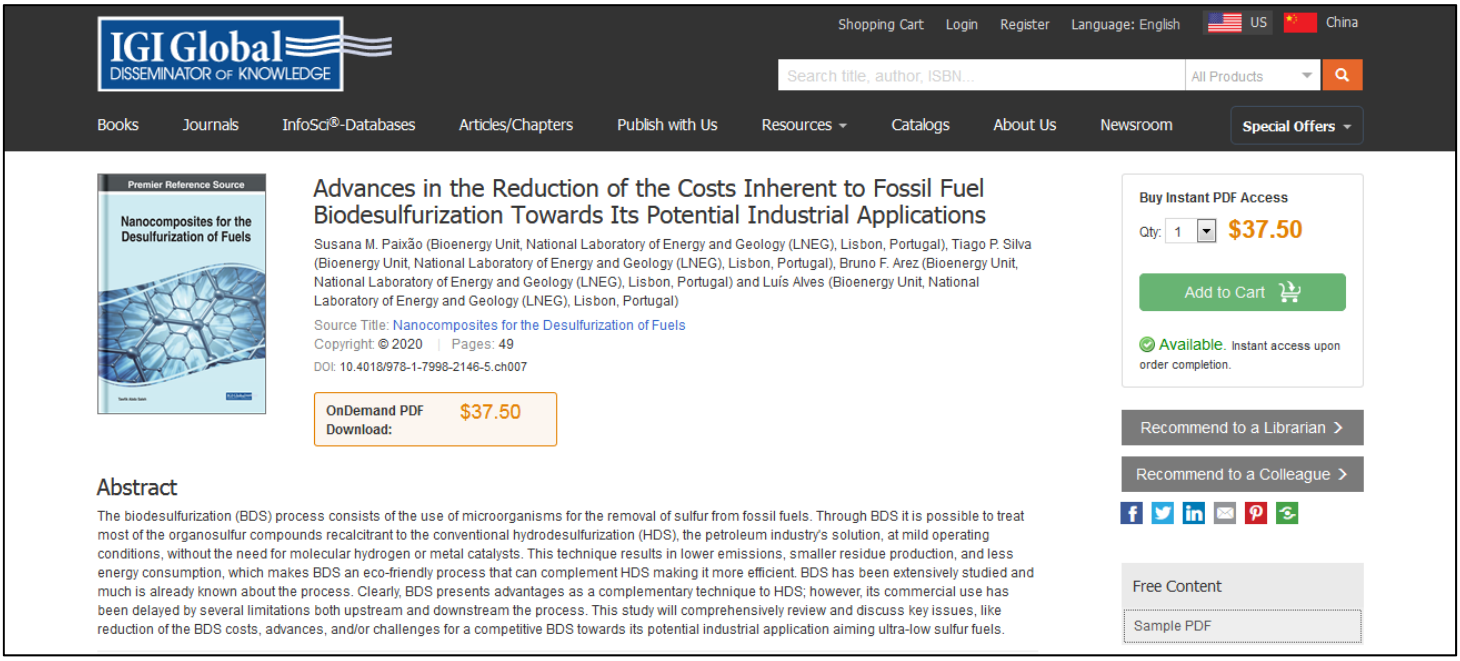


## Abstract

The biodesulfurization (BDS) process consists of the use of microorganisms for the removal of sulfur from fossil fuels. Through BDS it is possible to treat most of the organosulfur compounds recalcitrant to the conventional hydrodesulfurization (HDS), the petroleum industry's solution, at mild operating conditions, without the need for molecular hydrogen or metal catalysts. This technique results in lower emissions, smaller residue production, and less energy consumption, which makes BDS an eco-friendly process that can complement HDS making it more efficient. BDS has been extensively studied and much is already known about the process. Clearly, BDS presents advantages as a complementary technique to HDS; however, its commercial use has been delayed by several limitations both upstream and downstream the process. This study will comprehensively review and discuss key issues, like reduction of the BDS costs, advances, and/or challenges for a competitive BDS towards its potential industrial application aiming ultra-low sulfur fuels.

# Chapter 7
# Advances in the Reduction of the Costs Inherent to Fossil Fuel Biodesulfurization Towards Its Potential Industrial Applications

**Susana M. Paixão**
https://orcid.org/0000-0003-0955-4467
*Bioenergy Unit, National Laboratory of Energy and Geology (LNEG), Lisbon, Portugal*

**Tiago P. Silva**
*Bioenergy Unit, National Laboratory of Energy and Geology (LNEG), Lisbon, Portugal*

**Bruno F. Arez**
*Bioenergy Unit, National Laboratory of Energy and Geology (LNEG), Lisbon, Portugal*

**Luís Alves**
*Bioenergy Unit, National Laboratory of Energy and Geology (LNEG), Lisbon, Portugal*

## ABSTRACT

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*Clearly, BDS presents advantages as a complementary technique to HDS; however, its commercial use has been delayed by several limitations both upstream and downstream the process. This study will comprehensively review and discuss key issues, like reduction of the BDS costs, advances, and/or challenges for a competitive BDS towards its potential industrial application aiming ultra-low sulfur fuels.*

## INTRODUCTION

The combustion of fossil fuel generates emissions of sulfur as sulfur dioxide ($SO_2$), which is corrosive and toxic, and as fine particulate matter of metal sulfates. These emissions are responsible for damage in many different areas. Gaseous chemical compounds of sulfur constitute a major health hazard when present in the air: the large-ring thiophenes, such as dibenzothiophene, abundant in crude oil, are toxic to mammals (Murphy, Amin, Coletta, & Hoffman, 1992); $SO_2$ gas at high levels can cause bronchial irritation and trigger asthma attacks in susceptible individuals and long-term exposure to combustion-related one particulate air pollution is an important risk factor for cardio-pulmonary and lung cancer mortality (Pope et al., 2002; Mohebali & Ball, 2008). In addition, incomplete burning of liquid fossil fuels causes emissions of aromatic sulfur compounds to the air (Ho & Li, 2002), and the oxidation of sulfur compounds in the atmosphere eventually leads to an aerosol of sulphuric acid. This aerosol causes acid rains, which are responsible for the corrosion of many infrastructures and monuments, and even affect several living organisms including agricultural crops, thus causing direct damage to the economy (Bender & Weigel, 2011). The aerosol is also harmful to the stratospheric ozone contributing to the hole on the Earth's protective ozone layer (Denis, 2010). Lastly, sulfur compounds even prevent the functioning of all major pollution control technologies such as automobile catalytic converters (Maricq, Chase, Xu, & Laing, 2002), making it more difficult to fight against pollution.

Since gasoline, diesel and non-transportation fuels account for 75 to 80% of the total refinery products (Babich & Moulijn, 2003), it is only natural that countries find the reductions of sulfur concentration in fuels as the most effective way to decrease the amount of $SO_2$ emitted in to the air and limit its prejudicial effects (Mohebali, Ball, Kaytash, & Rasekh, 2008).

Therefore, in response to the increasing concerns with environmental and health effects of the $SO_x$ molecules, several countries have started to impose strict limits on the levels of sulfur present in fossil fuels. This forced the petroleum industry to develop techniques which remove the sulfur from the fuels, such as hydrodesulfurization (HDS), a process that combines high temperatures and pressures with molecular hydrogen in the presence of complex metal catalysts. However, this process is not very effective at removing heterocyclic sulfur compounds, which can account