

Menú de navegación

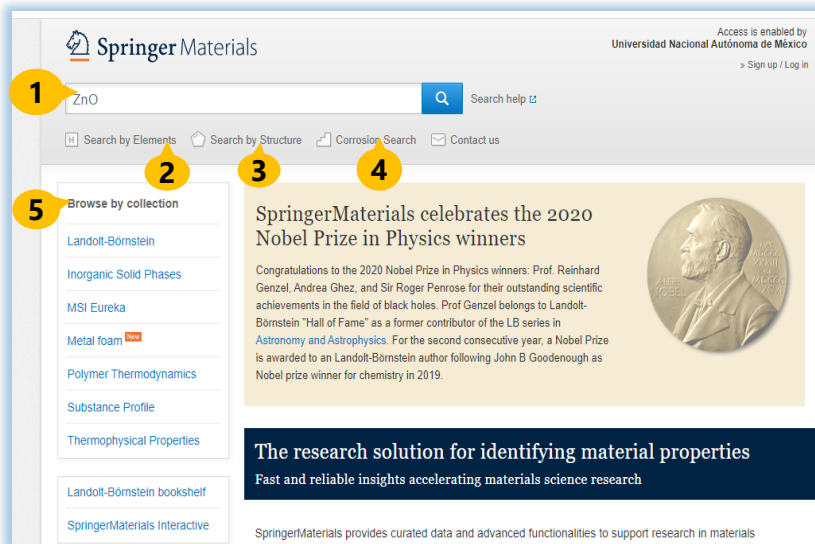
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3) Search structure: la búsqueda por estructura ofrece la opción de dibujar y buscar estructuras químicas utilizando herramientas integradas con opciones de dibujo avanzadas. Los resultados de la búsqueda de estructuras incluyen subestructuras de coincidencia exacta y relevantes clasificadas por un porcentaje de similitud.

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Búsqueda avanzada

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Página de resultados

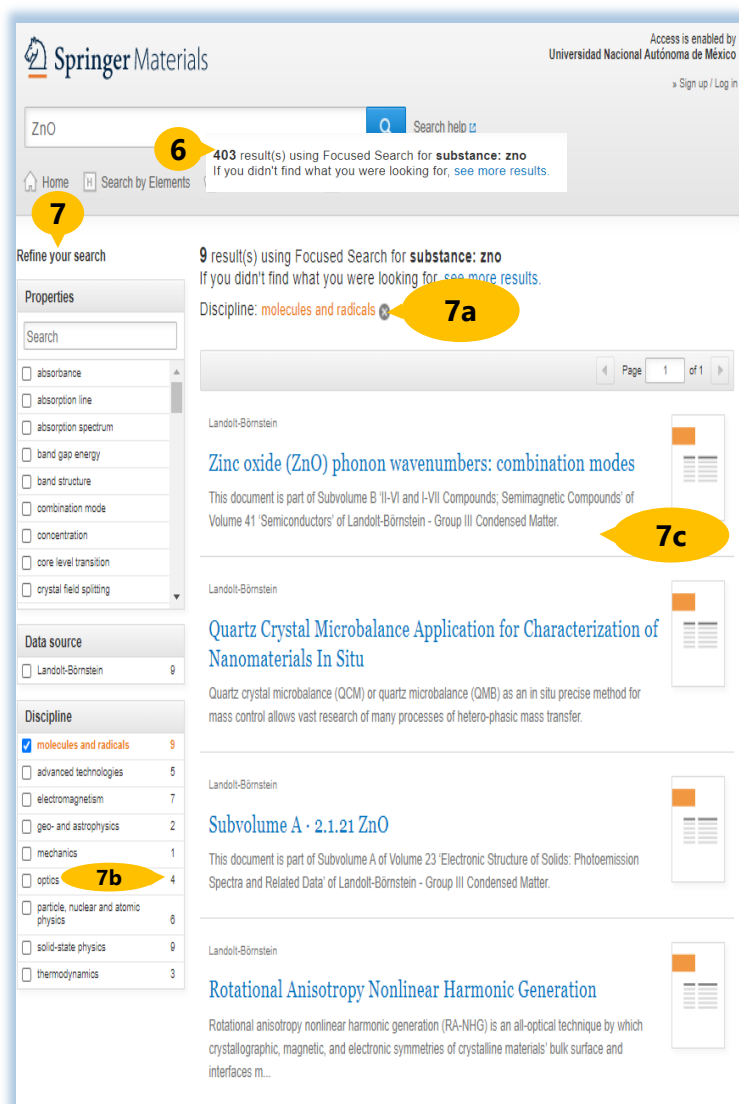
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Quartz Crystal Microbalance Application for Characterization of Nanomaterials In Situ

Abstract

Quartz crystal microbalance (QCM) or quartz microbalance (QMB) as an in situ precise method for mass control allows vast research of many processes of hetero-phase mass transfer.

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References (73)

About this content

Title Quartz Crystal Microbalance Application for Characterization of Nanomaterials In Situ	Editors Challa S.S.R. Kumar ⁽¹⁾
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Quartz crystal microbalance (QCM) or quartz microbalance (QMB) as a measurement tool could monitor changes in mass on the scale of nano to pico grams in real time as well as registering precise changes in viscoelastic properties and structures of materials on thin films, even in cases where such accuracy cannot be achieved with atomic force microscopy. It is therefore a highly necessary and desired research tool in the study of nanomaterials.

Here, we look at the application of QCM for the study of processes related to the growth and degradation of nanostructures and ultrathin films, and the detection of molecular analytes by sensor-nanomaterials and nanoparticle-analytes on specialized receptors. Moreover, a large portion of this work is dedicated to the application of QCM in research of nanostructures transport in different ecosystems as well as nanomaterial toxicology.

3 Introduction

The piezoelectric effect is the occurrence of an electrical potential on certain materials due to mechanical deformation (e.g., quartz). The effect was first discovered in 1880 by Paul-Jacques and Pierre Curie [1]. A year later in 1881, a reverse effect was hypothesized by Lippman [2], which was experimentally proven by the Curie brothers later on that year [3]. Nevertheless, the mathematical analysis, connecting the reverse piezoelectric effect with the changes in a resonator's mass, appeared only 77 years later in the work of Sauerbrey [4]. The proposed method allowed conducting measurements of changes in a resonator's mass with very high sensitivity, which was limited only by the nature of the quartz crystal, used for this purpose. The later was the basis of the development of the quartz crystal microbalance (QCM). Modern day piezoelectric quartz crystal resonators (QCR) can detect changes in mass on the scale of 10^{-7} – 10^{-12} grams. A disadvantage of the method is the relatively narrow range of measurement.

Due to the high precision and sensitivity, QCM was widely used for different applications: (a) for quality control of layer depositions, to allow evaluating the thickness of the deposited layer; (b) for piezoelectric mass sensors armed with layers of receptors, ensuring selective binding of an analyte; (c) for research purposes of investigating in situ processes of deposition and growth of layers.

The rapid development of nanoscience and nanotechnology in the last decade of the twentieth century renewed the interest of the scientific community in QCM. Foremost, it became apparent that QCM is irreplaceable as an instrument of in situ measurements of thin layer thickness in electronics in both chemical and physical vapor deposition (CVD and PVD, respectively) apparatus [5], even with recent developments in process technology (14–10 nm) [6]. Moreover, it is possible to utilize QCM not only for layer thickness control but also for the studies of nanomaterial growth and aggregation from both gas and liquid phases [7].

Work in the field of nanomaterials introduced the concept of nanomaterials as receptor layers on piezoelectric mass sensors [8, 9].

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