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www.nature.com/scientificreports

Received: 23 March 2017  
Accepted: 15 December 2017  
Published online: 10 January 2018

**OPEN**

## Physiological effects of short acute UVB treatments in *Chenopodium quinoa* Willd

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**Increased ultraviolet B (UVB) radiation due to global change can affect plant growth and metabolism. Here, we evaluated the capacity of quinoa to resist under short acute UVB irradiation. Quinoa was daily exposed for 30 or 60 min to 1.69 W m<sup>-2</sup> UVB. The results showed that 30 min exposure in 9 d-course did not cause severe alterations on photosynthetic pigments and flavonoids, but a significant increase of antioxidant capacity was observed. Otherwise, 60 min UVB in 5 d-course reduced almost all these parameters except for an increase in the de-epoxidation of xanthophyll cycle pigments and led to the death of the plants. Further studies of gas exchange and fluorescence measurements showed that 30 min UVB dramatically decreases stomatal conductance, probably associated to reactive oxygen species (ROS) production. Inhibition of photosynthetic electron transport was also observed, which could be a response to reduce ROS. Otherwise, irreversible damage to the photosynthetic apparatus was found with 60 min UVB probably due to severe ROS overproduction that decompensates the redox balance inducing UVB non-specific signaling. Moreover, 60 min UVB compromised Rubisco carboxylase activity and photosynthetic electron transport. Overall, these data suggest that quinoa modulates different response mechanisms depending on the UVB irradiation dosage.**

Solar radiation is the primary source of energy for metabolism in plants and for the regulation of their growth and development. Depletion of the stratospheric ozone layer, a component of global climate change, has prompted studies on the effect of enhanced ultraviolet B (UVB) radiation on growth and yield of agriculture crops<sup>1–3</sup>. Although UVB only represents a fraction of the solar spectrum, its high energy has a substantial impact on living organisms<sup>4</sup>. It has been reported that depending on the flow rate, duration and interaction with other environmental factors, the UVB radiation can induce photomorphogenic and stress responses which are not mutually exclusive. Thus, exposure of plants to low doses of UVB can induce photomorphogenic effects via the UVB-BINDING LOCUS8 (UVB8) photoreceptor<sup>5</sup>. However, high UVB doses can induce the production of reactive oxygen species (ROS), reduction of photosynthesis and damages to cell membranes, proteins and DNA<sup>6,7</sup>. In natural environments, the intensity of UVB radiation depends on the season, latitude, altitude and cloudiness, leading to wide temporal and spatial dynamics. Intense UVB radiation is a common characteristic of the Andean

**Preparación, caracterización y aplicación de sensores de Pd-SnO como nariz electrónica en la clasificación de vinos peruanos y su comparación con técnicas cromatográficas**

**Resumen**

Se prepararon sensores basados en SnO dopados con paladio (0, 1, 3, 5 y 7%) mediante el método de impregnación húmeda. Para caracterizarlos, se usaron las técnicas de espectroscopia infrarroja con transformación de Fourier (FTIR), adsorción y desorción de N<sub>2</sub> (BET), XRD, microscopía electrónica de varredura (SEM) y espectroscopia de energía dispersiva de rayos X (EDX). Los sensores se evaluaron en etanol para que conformaran, junto a dos sensores comerciales, una nariz electrónica (*Sensor*) que logre detectar componentes volátiles del aroma en vinos peruanos. Los resultados fueron interpretados a través del análisis de componentes principales (PCA) con la finalidad de buscar una técnica que complementase la información recolectada por la cromatografía de gases (GC) y la cromatografía líquida (HPLC), y justamente comparando los PCA obtenidos del GC y el HPLC con los resultados de la *Sensor* se encontró que estos últimos clasificaban mejor las muestras. Fue posible diferenciar todos los vinos de la misma uva y de diferentes variedades, así como detectar adulterados, cuyo contribuye a la industria vitivinícola en el control de su producción con la finalidad de mejorar la calidad de esta bebida para el consumidor.

**Palabras clave:** sensor de gas, paladio, nariz electrónica, vinos peruanos.

**Preparation, characterization, and application of Pd-SnO sensors as an electronic nose in Peruvian wine classification and its comparison with chromatographic techniques**

**Abstract**

SnO-based sensors doped with palladium (0, 1, 3, 5 and 7%) were prepared by the wet impregnation method. To characterize them, the techniques of infrared spectroscopy with Fourier transform (FTIR), adsorption and desorption of N<sub>2</sub> (BET), XRD, scanning electron microscopy (SEM), and X-ray dispersive energy (EDX) spectroscopy were used. The sensors were evaluated with ethanol to form, together with two commercial sensors, an electronic nose (*Sensor*) that could detect volatile aroma components in Peruvian wines. The results were interpreted through principal component analysis (PCA) to find a technique that complemented the information collected by gas chromatography (GC) and liquid chromatography (HPLC), and by comparing the PCAs obtained from GC, and HPLC with those resulting from *Sensor*. It was found that the latter classified the samples better. It was possible to differentiate both wines from the same grape and from a different strain, and to detect adulterated wines, which contributes to the wine industry in controlling its production to control the quality of this drink for the consumer.

**Keywords:** Gas sensor, palladium, electronic nose, Peruvian wine.

**Preparação, caracterização e aplicação de sensores de Pd-SnO como nariz eletrônico na classificação dos vinhos peruanos e sua comparação com técnicas cromatográficas**

**Resumo**

Os sensores baseados em SnO dopados com paládio (0, 1, 3, 5 e 7%) foram preparados pelo método de impregnação por via húmida. Para caracterizá-los, as técnicas de espectroscopia infravermelha com transformação de Fourier (FTIR), adsorção e desorção de N<sub>2</sub> (BET), XRD, microscopia eletrônica de varredura (SEM) e espectroscopia de energia dispersiva de raios X (EDX). Os sensores foram avaliados com etanol para formar, junto com dois sensores comerciais, um nariz eletrônico (*Sensor*) que poderia detectar componentes de aroma volátil em vinhos peruanos. Os resultados foram interpretados através da análise de componentes principais (PCA) para encontrar uma técnica que complementasse a informação coletada por cromatografia de gases (GC) e cromatografia líquida (HPLC), e comparando os PCA obtidos de GC e HPLC com os resultados de *Sensor*, descobriu-se que estes últimos melhoravam a classificação das amostras. Foi possível diferenciar os vinhos da mesma uva e de uma variedade diferente, além disso, foi possível detectar vinhos adulterados, o que contribui para a indústria do vinho no controle da qualidade do produto, a fim de melhorar a qualidade desta bebida para o consumidor.

**Palavras-Chave:** sensor de gás, paládio, nariz eletrônico vinhos peruanos.

Química Aplicada y Analítica

## Full molecular trajectories of RNA polymerase at single base-pair resolution

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Received: 23 March 2017; revised by Laura Finzi and David J. Keller

In recent years, highly stable optical tweezers systems have enabled the characterization of the dynamics of molecular motors at very high resolution. However, the motion of many motors with angstrom-scale dynamics cannot be consistently resolved due to poor signal-to-noise ratio. Using an acousto-optic deflector to generate a “time-shared” dual-optical trap, we decreased low-frequency noise by more than one order of magnitude compared with conventional dual-trap optical tweezers. Using this instrument, we implemented a protocol that synthesizes single base-pair trajectories, which are used to test a Large State Space Hidden Markov Model algorithm to recover their individual steps. We then used this algorithm to real transcription data obtained in the same instrument to fully uncover the molecular trajectories of *Escherichia coli* RNA polymerase. We applied this procedure to reveal the effect of pyrophosphate on the distribution of dwell times between consecutive pyrophosphate steps.

Optical tweezers | transcription | single molecule | step-finding

Proteins involved in a wide array of cellular functions are able to convert chemical energy into mechanical motion, thus functioning as molecular motors (1). A comprehensive description of the dynamics of such motors requires following their position with sufficient spatiotemporal resolution to determine their molecular trajectory. The trajectories of all motors described to date consist of alternating stationary periods (known as “dwells”) and translocation events (known as “bursts”). From these trajectories, we can extract fundamental parameters of a motor’s dynamic operation, such as the distribution of its step sizes and dwell times; these parameters, in turn, provide crucial insight into the mechanochemical coupling underlying the motor’s operation. For motors, such as dynein, that take steps with variable sizes (2), characterization of the molecular trajectory reveals how the motor adapts its step size to the conditions under which it operates (external load, ATP concentration, crowded environment, etc.). Conversely, knowledge of the dwell time distribution can, for example, shed light on the coordination mechanism in multiunit motors (3–6).

Optical trapping can be used to characterize molecular motor dynamics with high precision over biologically relevant times, distances, and forces. The molecular trajectories of motors that take relatively large steps (such as kinesin, which takes 8 nm steps on microtubules) are now regularly accessed in many laboratories. However, the ability to reliably and routinely resolve the molecular trajectories (including all steps and interstep dwell times) of many nucleic acid-associated motors (e.g., DNA and RNA polymerases, helicases, dsDNA translocases, etc.), whose steps are on the order of 1 bp (~3.4 Å), continues to elude biophysicists. While base-pair stepping by RNA polymerase and

order of tens of seconds) and infrequently enough that upwards of 90% of the data have to be ignored and discarded (9). Thus, extraction of molecular trajectories with base-pair resolution in a reliable and consistent way has not been possible until now.

Here, we compare the resolution of split-path and time-shared optical tweezers instruments under identical conditions. We show that the ability to robustly extract trajectories with single base-pair resolution is limited by low-frequency noise present in the split-path design but not in the time-shared design. We introduce a protocol to experimentally synthesize trajectories simulating single base-pair stepping by a molecular motor. The synthesized data are used to evaluate the fitness of the teller and to test the performance of a Large State Space Hidden Markov Model (LSS-HMM) algorithm in extracting the corresponding molecular trajectories. Finally, we use this same algorithm to extract the full molecular trajectories (steps and dwells) of *Escherichia coli* RNA polymerase from transcription traces obtained in the time-shared instrument and to characterize the effect of pyrophosphate (PPi) on the distribution of dwell times between steps of the enzyme.

**Theory**

The fluctuations of a microscopic bead held in a harmonic trap of stiffness  $k$  are described by its power spectrum. According to the fluctuation-dissipation theorem, the random, uncorrelated forces due to the collisions of surrounding molecules (at a

**Significance**

Optical tweezers enable scientists to follow the dynamics of molecular motors at high resolution. The ability to discern a motor’s discrete steps reveals important insights on its operation. Some motors operate at the scale of angstroms, rendering the observation of their steps extremely challenging. In some cases, such full steps have been observed sporadically; however, the full molecular trajectories of steps and intervals between steps remain elusive due to instrumental noises. Here, we eliminate the main source of noise of most high-resolution dual-trap optical tweezers and developed both a single-molecule assay and a self-learning algorithm to uncover the full trajectories of such a motor. RNA polymerase. Using this method, a whole new set of experiments becomes possible.

Author contributions: M.R., A.L., T.L., R.G., Y.C., J.T., and C.B. designed research; M.R., C.C., T.L., and Y.C. performed research; R.G. contributed new reagent(s)/analytic tools; A.L., M.R., I.T., and C.B. wrote the paper.  
Reviewers: L.F., Emory University; and D.J.K., University of New Mexico.  
Conflict of interest statement: C.B. and D.J.K. are collaborating on a forthcoming book.  
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Food Chemistry 262 (2018) 94–101

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

## NMR-based metabolic study of fruits of *Physalis peruviana* L. grown in eight different Peruvian ecosystems

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**ARTICLE INFO**

**Keywords:** *Physalis peruviana* L., NMR metabolomics, Quantitative NMR, Amino acid profile, Sugar profile, Peruvian highlands

**ABSTRACT**

The berry of *Physalis peruviana* L. (Solanaceae) represents an important socio-economic commodity for Latin America. The absence of a clear phenotype renders it difficult to trace its place of origin. In this study, Cape gooseberries from eight different regions within the Peruvian Andes were profiled for their metabolite complementing a NMR platform. Twenty-four compounds could be unequivocally identified and sixteen quantified. One-way ANOVA and *post-hoc* Tukey test revealed that all of the quantified metabolites changed significantly among regions. Bannamurra showed the most accumulated significant differences. The coefficient of variation demonstrated high phenotypic plasticity for amino acids, while sugars displayed low phenotypic plasticity. Correlation analysis highlighted the closely coordinated behavior of the amino acid profile. Finally, HPLC-DA revealed a clear separation among the regions based on their metabolite profiles, accentuating the discriminatory capacity of NMR in establishing significant phytochemical differences between producing regions of the fruit of *P. peruviana* L.

**1. Introduction**

*Physalis peruviana* L. (Solanaceae) is a perennial plant known for the Peruvian Andes since pre-Columbian times (Legge, 1974). Nowadays, it is commercially cultivated in Colombia, Ecuador, Peru, and various non-Andean countries, such as Australia, India, New Zealand, South Africa, and the United States (Puentes, Pinto-Muñoz, Castro, & Cortés, 2011). The importance of this plant relies on the juicy edible orange fruit it produces, known as Cape gooseberry (CG) in English speaking countries, while in Latin American regions it is known as “aguaymanto”, “tomatillo”, “capuli”, or “uchuva”. The global interest on this product has increased during the last decade due to the nutraceutical benefits known for the fruit (Olivares-Tenorio, Dekker, Verkerke, & van Boekel, 2016; Puentes, et al., 2011).

Cape gooseberries are rich in protein, essential fatty acids, vitamins (ascorbic acid,  $\beta$ -carotene, vitamin K, niacin, vitamin E), phenolics, carbohydrates (glucose, fructose, sucrose), fiber, pectin, and minerals (primarily phosphorus and iron) (Olivares-Tenorio, et al., 2016). More than 100 different compounds associated with flavor, among volatiles and non-volatiles, have been identified in fresh CG (Vismarstein, 2014). The scattered studies available on the chemistry of this fruit are based on classical chromatographic methods, such as high-performance liquid chromatography coupled to an ultraviolet detector, or gas chromatography with mass spectrometry detection, e.g. recently used to report on differences among CGs grown under organic and conventional conditions (Llano, Muñoz-Jiménez, Jiménez-Cartagena, Londondro-Londoño, & Medina, 2018).

Despite its importance, genetic studies of *P. peruviana* L. do not abound. Solely three genetic reports were detected in the scientific literature, namely, Simbaqueba et al. (2011) who analyzed microsatellite composition of *P. peruviana* L. accessions in the leaf, while Garzón-Martínez Zhu Landmann Barrero and Marín-Ramírez (2012) studied the leaf transcriptome, and Nohra & Rodríguez (2006) reported on the cytogenetic diversity of different ecotypes.

Colombia, Kenya, and South Africa are the most commercialized ecotypes and therefore the best characterized botanically, agronomically, and biochemically (Bravo, Sepúlveda-Ortega, Lara-Guzmán, Navas-Arboleda, & Osorio, 2015; Fischer, Ebert, & Lidders, 2007; Fischer, Ebert, & Lidders, 1999). In contrast, little can be said about the Peruvian ecotype. The plants, which distribute between 1000 and 4000 m above sea level (msal) along different Andean ecosystems in the regions of Areca, Huánuco, Junín, Ayacucho, Arequipa, Cajamarca, and Cusco (Cano, et al., 2012) cannot be discriminated phenotypically and no chemical information regarding their differences is yet available.

Metabolic phenotyping, a state-of-the-art analytical approach that

\* Solo se incluyen artículos de miembros de la Sección Química de la PUCP que aparezcan firmados con la afiliación a esta sección, independientemente de si los colaboradores son, o no, de la PUCP y que hayan sido publicados en números con fecha formal de 2018 (la recopilación se hizo hasta 31 de julio 2018). El acceso al artículo depende de la suscripción del usuario a las editoriales correspondientes. Se han incluido solo revistas científicas que se encuentran indexadas en las bases de datos Scopus y Web of Science, de reconocido prestigio internacional.

## Combustion synthesis and characterization of $\text{Ln}_{1-x}\text{M}_x\text{Cr}_{0.9}\text{Ni}_{0.1}\text{O}_3$ (Ln = La and/or Nd; M = Sr and/or Ca; $x \leq 0.25$ ) perovskites for SOFCs anodes

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### ARTICLE INFO

Keywords:  
Chemical synthesis  
Electrical conductivity  
SOFC  
Anode  
A-site

### ABSTRACT

A series of chromite perovskites with the general formula  $\text{Ln}_{1-x}\text{M}_x\text{Cr}_{0.9}\text{Ni}_{0.1}\text{O}_3$  (Ln = La and/or Nd; M = Sr and/or Ca;  $x \leq 0.25$ ) has been prepared by three combustion synthesis routes using a different combustible substance each time: glycine, urea and sucrose. In order to isolate the effect of divalent dopant concentration from the A cation steric effects, the whole group has a fixed mean A cation radius,  $r_A > 1.22$  Å, and cation size disorder,  $\sigma(r_A) = 0.0001$  Å, but variable doping  $x$ . Their crystal structure, microstructure, electrical properties and expansion coefficients have been investigated on the basis of their possible use as anode materials for intermediate temperature solid oxide fuel cells (SOFC). Cell parameters, grain sizes, expansion coefficients and conductivities all are found to be dependent on  $x$  and the combustible substance used. The most interesting relationship is the negative dependence of the conductivity with  $x$  under  $\text{H}_2$  atmosphere: conductivity decreases with doping which is the opposite to the expected behavior for a p-type doped perovskites and has not been reported before.

### 1. Introduction

The research to find new or to improve the most commonly used materials in solid oxide fuel cells (SOFC) is still a important field in materials science [1]. In particular, one of the most active area is the study of SOFC anodes because the operation of commercial SOFC devices is strongly dependent on the behavior of this electrode, which is in contact with the fuel (and all its impurities) [2]. The number of materials studied as possible anodes is huge and, among them, perovskites have also gained attraction due to their good catalytic properties, high ionic and electrical conductivities, and their chemical and thermal stabilities at high temperatures.

The main concern for current nickel-yttria stabilized zirconia cement anodes is that they are unable to work efficiently with hydrocarbon fuels at intermediate operating temperature range (600–800 °C) due to their sulfur content and also as a consequence of carbon deposition [3]. Hence, there is still a demand for the development of alternate anode materials with improved tolerance towards carbon deposition and sulfur poisoning to improve the fuel flexibility and efficiency of SOFCs.

Oxide-perovskites have been widely studied as possible cathode electrodes for a long time due to their mixed ionic and electronic conductivity (MIEC), high catalytic activity and good stability under oxidizing conditions [1,4]. To be used as anodes, however, perovskites need to be stable under reducing conditions. Among the oxide perovskites that have good catalytic properties and appropriate MIEC, only chromites are reasonably stable in reducing atmospheres and this is why they have been thoroughly investigated as SOFC-interconnectors [5] and also proposed as possible anodes [6–11]. From the thermodynamic point of view, chromites are expected to react with the common YSZ electrolyte but in practice, this only occurs to a great extent at temperatures above the operation ones (that is, higher than 1000 °C) [12].

When a material is evaluated as a SOFC component, it is also important to consider its preparation costs. Perovskites are usually prepared at high temperatures so another important field of research is aimed at reducing energy consumption of the synthesis [13]. Combustion synthesis routes, which involve low cost materials, short processing time and produce large amount of gases that inhibit particle size

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## Environmental impact of mining liabilities in water resources of Parac micro-watershed, San Mateo Huanchor district, Peru

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Received: 19 May 2016 / Accepted: 9 December 2016 / Published online: 20 December 2016  
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**Abstract** Before environmental legislation was enforced, worldwide mineral mines abandoned their operations without properly remediation and closure affecting the ecosystems. Because of its geological richness, Peru has attracted mining activities since colonial times and more than 8571 mining liabilities have been left. Pacochocha and Millotingo mining liabilities are located on the banks of Aruri River, above Parac micro-watershed, from where communities of San Jose de Parac and San Antonio (San Mateo Huanchor district, Lima) take water for irrigating crops in low-flow periods. This paper reports for the first time in Peru the use of an interdisciplinary approach to examine the environmental effects of mining liabilities and small-scale mining on peasant communities. Physical and chemical methods, such as microscopy and spectrometry, were used to verify the presence of sulfides and to measure critical water quality parameters of Aruri and Rimac rivers. The ecosystem approach was applied to collect socioeconomic information from both communities; social actors and their statements regarding tailing problems were identified by social multi-criteria evaluation. It was found that the tailings contained sulfides that provide arsenic, cadmium, copper, zinc and manganese to Aruri and Rimac rivers in levels that exceed State of Oregon (USA) standard limits. It was also observed that both communities use this water to irrigate potato and alfalfa crops, well-known bioaccumulators. The tailings were classified as high risk to the environment by the Peruvian General Direction of Mining; however, future remediation remains uncertain due to a judicial dispute.

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### CRITICAL REVIEW

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## In-cell NMR: from metabolites to macromolecules

Cite this: DOI: 10.1039/c7an01635b

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In-cell NMR of macromolecules has gained momentum over the last ten years as an approach that bridges the branches of cell biology and structural biology. In this review, we put in the context of each field that aimed to characterize by NMR the cellular environment of live cells and their intracellular metabolites. Although technical aspects distinguish these earlier *in vivo* NMR studies and the more recent *in cell* NMR efforts to characterize macromolecules in a cellular environment, we believe that both major concerns ranging from sensitivity and line broadening to cell viability. Approaches to overcome limitations in one subfield thereby can serve the other one and vice versa. The relevance in biomedical sciences might stretch from the direct following of drug metabolism in the cell to the observation target binding, and thereby encompasses *in-cell* NMR both of metabolites and macromolecules. underline the efforts of the field to move to novel biological insights by some selected examples.

Received 3rd October 2017  
Accepted 7th January 2018  
DOI: 10.1039/c7an01635b  
rsc.li/analyst

### Introduction

*In-cell* NMR can be defined as the NMR analysis of biochemical molecules in the "natural" environment of the cell, and should be compared to the myriad of imaging techniques that have expanded so greatly the realm of cellular biology in the last decades. "Orchestrated dance of molecules" or "macromolecular choreography" are terms commonly used in cell biology to indicate the assembly of molecular machinery that exerts complex functions such as DNA repair<sup>1</sup> or autophagy.<sup>2</sup> The cell is thereby seen as the organized unit of life rather than as a bag full with the components of life that would have been thrown in randomly.<sup>3</sup> Cell biology heavily relies on the capacity of visualizing different molecules with a subcellular spatial and temporal resolution that ideally allows to observe molecules in motion. The palette of colors is ever-expanding, and has basically gone from tagging with a single GFP fusion protein<sup>4</sup> to organic dyes allowing for multiplexed vision.<sup>5</sup> The influence of the label as well as (the need for) overexpression of the proteins under study is a real concern. Ideally, one would love to see the different molecules without labeling and at their endogenous level of expression. Cryo-electron

microscopy and/or tomography are striving for this NMR spectroscopy has at least this distinct advantage that labels come under the form of stable isotopes with a spin such as <sup>15</sup>N, <sup>13</sup>C or <sup>19</sup>F, that are clearly of limited invasiveness. This allows to study the structure and dynamics of a molecule in the cellular context, but how the molecule contributes to the cellular organization equally should remain focus.

Whereas the recent years of *in-cell* NMR have been dominated by studies showing either the feasibility of the approach or methods development concerning improved NMR detection<sup>6–16</sup> or protein delivery,<sup>17–20</sup> we prefer to focus our review on novel biological insights that have been gained by the approach. Before highlighting below some selected studies that go in this direction, you may want to do *in-cell* NMR at all? A first notion that steadily comes up in the community is "structural biology in the cell". However, when regard the other approaches that largely dominate structural biology, X-ray crystallography and recently cryo-electron microscopy have given tremendous insight in the function of the biomolecules mostly by elucidating mechanistic details and by suggesting novel experiments (based on mutational analysis) that test these insights in the cell. Although ignoring potential artifacts due to crystal contacts influence the resulting atomic coordinates, or the impact of the speed constructs including truncations and/or mutations required for crystallization, protein structures have truly opened completely novel fields of biological understanding and led to efficient drug molecules, even though they have been derived from purified and isolated molecules. *In-cell* NMR measurements can provide additional insight either by

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## Transition probabilities of $\text{Er}^{3+}$ ions in aluminosilicate glasses

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### ARTICLE INFO

Keywords:  
Rare earths  
Erbium ions  
Aluminosilicate glass  
Optical absorption  
Judd-Ofelt analysis

### ABSTRACT

The spectroscopic properties of Er-doped  $\text{Ca}_2\text{Al}_2\text{Si}_2\text{O}_{12}$  and  $\text{Mg}_2\text{Al}_2\text{Si}_2\text{O}_{12}$  glasses produced by the Laser Floating Zone technique are presented in this work. By measuring the absorption spectra and refractive index dispersion of the materials, JO parameters of the  $\text{Er}^{3+}$  ions have been obtained in both doped materials, where very good accordance between the experimental and theoretical electric dipole oscillator strengths is found. Using calculated electric and magnetic dipole strengths, the branching ratios of the different optical transitions of  $\text{Er}^{3+}$  in Ca and Mg glasses have been obtained, where the radiative lifetime of each level has also been calculated. The experimental lifetimes of the  $^4\text{S}_{3/2}$ ,  $^4\text{F}_{7/2}$  and  $^4\text{F}_{9/2}$  manifolds have been measured under pulsed excitation. These values have been related with the radiative lifetime calculated by the JO analysis, allowing to determine the non-radiative probabilities of the levels. In addition, a gap law has been established for both Ca and Mg aluminosilicate glasses. Finally, the covalency of the Er-O bond was studied in terms of the spectroscopic features of these glasses.

### 1. Introduction

The optical properties of rare-earth doped glasses have been investigated over the last decades. There are many applications for which the incorporation of trivalent rare-earth ions in a glass matrix allows developing active optical devices such as laser, IR-to-visible up-converters, optical amplifiers, phosphors, thermometry, etc [1–4]. Among the large variety of matrix composition studied, the most noteworthy are calcium silicate, calcium aluminosilicate and magnesium aluminosilicate glasses which are particularly suitable for practical applications due to their excellent mechanical properties (high elastic modulus and hardness), thermal properties (high thermal conductivity, high glass transition temperature), optical properties (wide transparent range and high refractive index) and good corrosion resistance [5]. Furthermore, the maximum phonon energy of silicate glasses ( $\sim 1050$  cm<sup>-1</sup>) is much lower compared to those of borate glasses ( $\sim 1350$  cm<sup>-1</sup>) and phosphate glasses ( $\sim 1300$  cm<sup>-1</sup>) [6–8], so quantum efficiency can be less influenced by the multiphonon relaxation process. In addition, silicate glasses contain glass network modifiers such as alkali ions and alkaline metal ions and the content of SiO<sub>2</sub> is not higher than 80 mol% in most cases. Due to its less defined glass networking broken by the glass network modifiers, such as sodium ions and calcium ions, silicate

glasses are capable of dissolving a much higher concentration of rare-earth ions, enhancing the efficiency of cross relaxation energy transfer and improving the quantum efficiency [6,7]. These properties have led to various applications in solid state lasers, optical waveguides, luminescence probes, and even in medicine as in vivo radiation delivery vehicles for cancer treatment of internal organs [9–15].

Furthermore, Er-doped glasses are particularly interesting because of the  $^4\text{I}_{13/2}$ – $^4\text{I}_{15/2}$  emission at 1.5 μm corresponding to the third communication window, and the  $^4\text{H}_{11/2}$ – $^4\text{H}_{13/2}$ ,  $^4\text{S}_{3/2}$ – $^4\text{I}_{15/2}$  and  $^4\text{F}_{9/2}$ – $^4\text{I}_{15/2}$  NIR-to-visible up-conversion emission bands centered at around 530, 550 and 665 nm [1,2,19]. Moreover,  $\text{Er}^{3+}$  ions can also be used as local ordering probe due to the close relation between their spectroscopic properties and the local structure and bonding at the ion site. It is well known that spectroscopic properties of trivalent rare-earth ions depend on the chemical composition of the glass matrix, which determines the structure and nature of the bonds, and thus spectroscopic characterization allows studying the local structure surrounding the RE ion and the covalency of the RE-O bond [5,20–25].

In this work, the spectroscopic properties and Judd-Ofelt analysis of Er-doped  $\text{Ca}_2\text{Al}_2\text{Si}_2\text{O}_{12}$  and  $\text{Mg}_2\text{Al}_2\text{Si}_2\text{O}_{12}$  glasses produced by the Laser Floating Zone technique are presented. These compounds always present an amorphous state when obtained at normal conditions. However,

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https://doi.org/10.1016/j.jlum.2018.06.003

Received 24 March 2018; Received in revised form 10 May 2018; Accepted 21 June 2018

Available online 22 June 2018

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