

## Dielectric Response in Natural Clinoptilolite

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**Abstract:** Several samples of cation forms of the natural clinoptilolite from Tassajeros deposit were studied using dielectric spectrometry. The behaviour of the response was analyzed for different water contents and, for the calcium and sodium forms, it was investigated for several temperatures too. The results show the influence of cation nature and water content in the shape and magnitude of the dielectric response. Two relaxation domains appear in the frequency range from 34 Hz to 500 kHz, which were studied following the formalism of the Universal Dielectric Response in solids. The existence of correlated motions between water-induced species and cations is discussed.

### INTRODUCTION

Natural clinoptilolite figures in the seventh group of the Meier's zeolite classification [1]. It constitutes a set of bidimensional arrays of interconnected channels, forming a low-dimensional system for cationic motions.

Dielectric relaxation techniques could provide a better understanding about the properties of zeolites as ionic exchangers, ionic conductors, catalysts or molecular sieves by studying the motions of cations, zeolitic water and adsorbed species. Dielectric studies have been carried out in different types of zeolites and under several experimental conditions [2-5]. They have been performed mainly for high-symmetry synthetic zeolites and sometimes have revealed controversial and inconsistent results. The latter could be a consequence of the lack of an adequate microscopic theory, which enable us to correlate the experimental results with any particular feature of each zeolitic structure.

In this work we used the Joncher's screened hopping model [6], for a qualitative interpretation of the dielectric response observed in the natural clinoptilolite from a Cuban deposit. The model used was the starting point for the known Universal Dielectric Response (UDR) [7], whose predictions have resulted to be in great accordance with experimental results on materials of most diverse chemical compositions and structures.

### EXPERIMENTAL

#### Sample preparation

Some homoclonic forms of natural clinoptilolite from Tassajeros deposit, for the cations  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Li}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$  and  $\text{Zn}^{2+}$  were classified in order to obtain 40  $\mu\text{m}$  powders. The samples were set at room humidity and temperature for 24 h. Later some of them were placed in a stove during 24 h for water extraction, and then they were grouped as in Table I. Samples of groups A and B were treated at 388 and 413 K, respectively; samples of group C were not thermally treated; and samples of group D were also placed at 413 K.

### Measurements

We used a planar-parallel type cell, with copper electrodes. The thickness of the samples after being tamped the powder inside the cell was always less than 2.50 mm, and the diameter, 26 mm, was fixed by the cell electrodes. The dielectric data were obtained from a Tesla BM 507 Impedance Meter.

Samples of groups A, B and C were measured at room temperature, and samples of group D were measured for several temperatures in the range from about 473 K down to room temperature.

## RESULTS AND DISCUSSION

### Water content influence

The dielectric response is presented in terms of the dielectric permittivity in log-log plots for the real and imaginary parts. Figure 1 shows the response of the divalent-cations forms of group A. Two relaxation domains are distinguished: one in the

Table I  
Separation of the samples used according to the preparation and measurements

| A                | B                | C                | D                |
|------------------|------------------|------------------|------------------|
| $\text{Na}^+$    | $\text{Na}^+$    | $\text{Na}^+$    | $\text{Na}^+$    |
| $\text{K}^+$     | $\text{K}^+$     | $\text{Ca}^{2+}$ | $\text{Ca}^{2+}$ |
| $\text{Li}^+$    | $\text{Li}^+$    | -                | -                |
| $\text{Ca}^{2+}$ | $\text{Ca}^{2+}$ | -                | -                |
| $\text{Mg}^{2+}$ | $\text{Mg}^{2+}$ | -                | -                |
| $\text{Zn}^{2+}$ | $\text{Zn}^{2+}$ | -                | -                |

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1. Understanding the eBook Ieee International Symposium On Electrical Insulation
  - The Rise of Digital Reading Ieee International Symposium On Electrical Insulation
  - Advantages of eBooks Over Traditional Books
2. Identifying Ieee International Symposium On Electrical Insulation
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Ieee International Symposium On Electrical Insulation
  - User-Friendly Interface
4. Exploring eBook Recommendations from Ieee International Symposium On Electrical Insulation
  - Personalized Recommendations
  - Ieee International Symposium On Electrical Insulation User Reviews and Ratings
  - Ieee International Symposium On Electrical Insulation and Bestseller Lists

5. Accessing Ieee International Symposium On Electrical Insulation Free and Paid eBooks
  - Ieee International Symposium On Electrical Insulation Public Domain eBooks
  - Ieee International Symposium On Electrical Insulation eBook Subscription Services
  - Ieee International Symposium On Electrical Insulation Budget-Friendly Options
6. Navigating Ieee International Symposium On Electrical Insulation eBook Formats
  - ePub, PDF, MOBI, and More
  - Ieee International Symposium On Electrical Insulation Compatibility with Devices
  - Ieee International Symposium On Electrical Insulation Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Ieee International Symposium On Electrical Insulation
  - Highlighting and Note-Taking Ieee International Symposium On Electrical Insulation
  - Interactive Elements Ieee International Symposium On Electrical Insulation
8. Staying Engaged with Ieee International Symposium On Electrical Insulation
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Ieee International Symposium On Electrical Insulation
9. Balancing eBooks and Physical Books Ieee International Symposium On Electrical Insulation
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Ieee International Symposium On Electrical Insulation
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Ieee International Symposium On Electrical Insulation
  - Setting Reading Goals Ieee International Symposium On Electrical Insulation
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Ieee International Symposium On Electrical Insulation
  - Fact-Checking eBook Content of Ieee International Symposium On Electrical Insulation
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
- Exploring Educational eBooks

### 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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