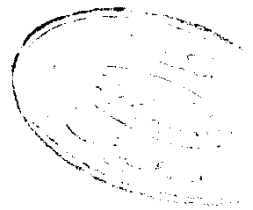
SPECTRAL AND IRRADIATION STUDIES ON DIFFERENT COLORS OF QUARTZ CRYSTALS



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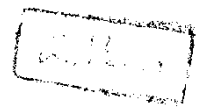

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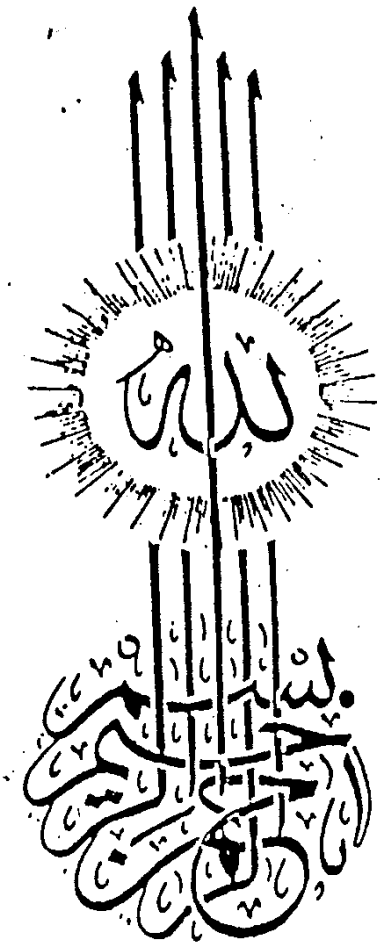

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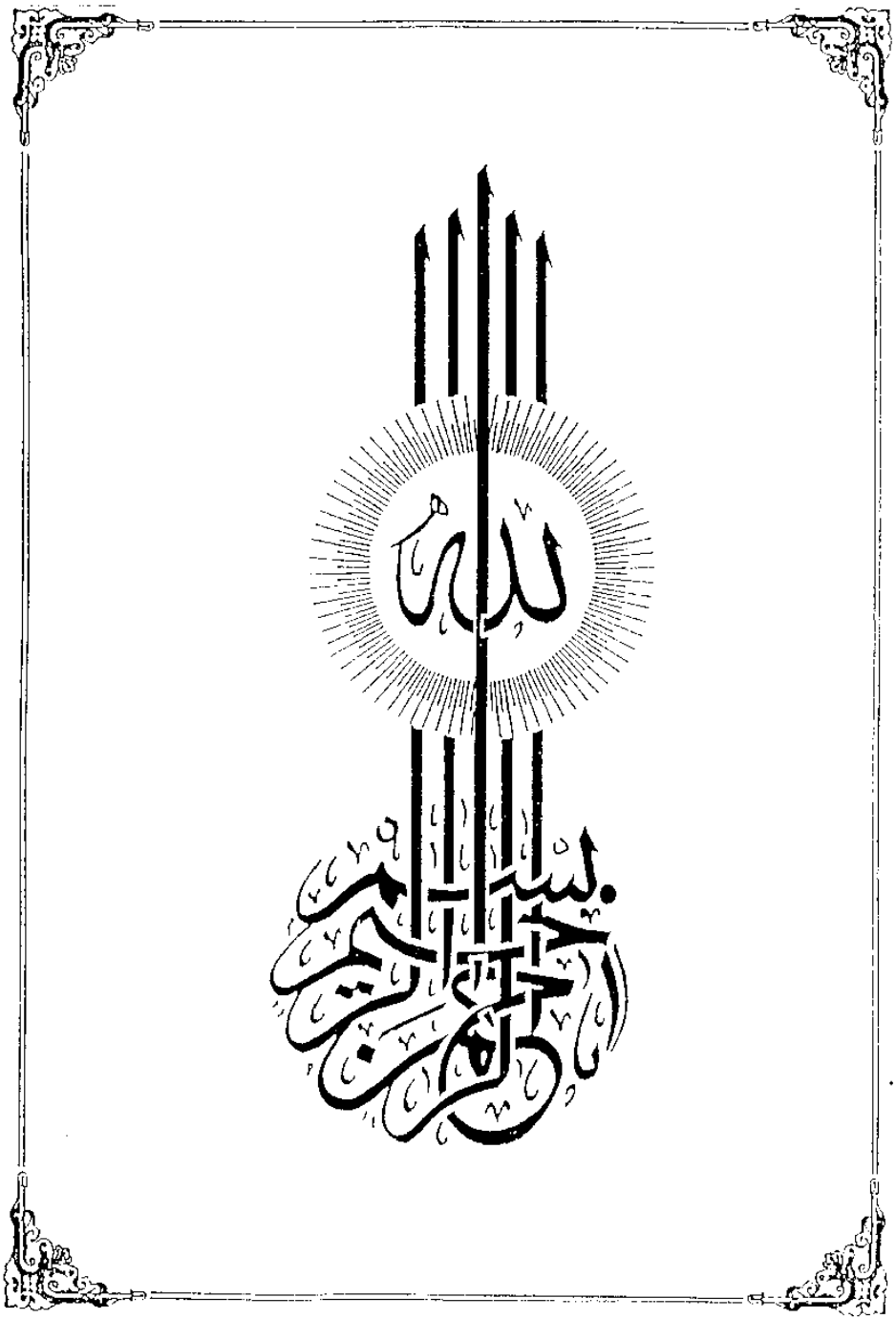

Spectral and irradiation studies

on different colors of quartz crystals

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CONTENTS

ABSTRACT

ABSTRACT

The structural imperfection and distribution of positive and negative charge in the ideal crystal are consisting an uninterrupted alteration of +ve and -ve ions. However, in the nature and according to the extensive studies, the real crystal do not attain the ideal structure picture, instead they may have a great structural imperfections, where-in occasional positive and negative ions are missing at random throughout the crystal structure. Furtheremore, in a pure crystal the number of missing + ve ions (vacancies) must equal the number of missing -ve ions (vacancies), in order that, the crystal are as a whole be electrically neutral. The absorption of proper thermal or optical excitation energy by the crystal can raise the trapped charge carriers from the ground state to one of its higher excited state and even sufficient excitation energy can expel these charge carriers from their vacancies "traps". The possibility of absorping thermal or optical energy make the crystal colored and the resulted charge carrier imperfection is called "color centers". Again induced effect of ionizing radiation may either producing an increasing probability of these vacancies and interstitials in the structure perfect region of the crystal or liberating free electron charges within the crystal lattice structure.

In the present study, the spectral and irradiation studies on colorless and smoky quartz crystal are studied in details. The different studied materials are grinded into fine powders of 80-200 mesh and then pressed into 3 mm diameter discs, each is about 10 mg weights. The different

prepared discs are thermally treated in different annealing temperatures, noted as 200, 300, 400, 500, 600 and 700°C for one hour before irradiation to gamma ray. The induced effects of different annealing courses as well as radiophotoluminescence sensitivity and behaviour for various types of quartz are studied in details.

Also, the relevant changes in the chemical composition of these materials is resolved by infrared spectroscopic analysis as well as by x-ray fluorescence. In general, the contents of the present thesis have been divided into five chapters.

In the first chapter, a general introduction is given which includes a general review on induced effects of radiation on color centers characterized the solid materials in use. The effect of the formation of these color centers on the physical and chemical behaviours of these natural materials is also discussed. This disscussion is carried out on basis of current literature as detailed review on the luminescence behaviour of these naturals as a physical changes. As well as the structure changes of the original material, its heated and irradiation products by infrared analysis is also presented as well as x-ray fluorescence analysis for the estimation of the elemental composition of the studied samples. The aim of the present work is also included.

The second chapter of this thesis exhibits a complete review on the theoretical concepts beside the phenomena of the luminescence, the infrared quantitative analysis as well as the x-ray qualitative analysis.

The third chapter includes details about the natural material under investigation, besides a quantitative analysis of the basic composition, the dopant concentration presented in these studied quartz samples and finaly the qualitative analysis of the basic composition. The radiation sources and their calibration γ-irradiation set up, are also included. This chapter is also detailed describing the thermoluminescence, the radiophotoluminescence, infrared and the x-ray measuring facilities and their calibration procedure.

The experimentally deduced results are also discussed in chapter four of the thesis through four main techniques. The deduced experimental results are beneficially explaining the gamma induced effects on the behaviour of the stimulated luminescence, either by (a) the effect of thermal energy, thermoluminescence as noted in the first technique and/or (b) by the effect of light energy, radiophotoluminescence as noted in the second technique. Furthermore, the gamma induced chemical changes of these studied quartz materials are also presented as quantitative analysis for the induced chemical changes of quartz composition using infrared spectroscopic analysis, as a third technique. And the energy dispersive x-ray fluorescence (EDXRF) technique is used as qualitative

analysis. Mostly, techniques one and two of this chapter reflect the beneficial use of that revealed gamma induced physical changes in the color centers as an induced luminescence of these studied material as status condition of the irradiation dose. The experimental results show in details the induced changes of dose response as a function of stimulated luminescence sensitivity and beside the stability of that radiation induced effects on the revealed physical changes. The intercomparison study for the different parameters affecting the induced physical changes of the two different quartz samples is also presented for the utilization in the field of dosimetry. The reproducibility and accuracy of the experimental results show pronouncing.

The presented study of the infrared as a third technique, shows pronounced difference in the obtained I.R. spectra of the original two studied quartz samples. In fact some new peaks appear in each sample. Moreover, these is a change in the shape and/or position of the fundamental bands. Heating effect products a great change in the absorptivity of the silicate and water bands at different temperatures with a maximum at 400°C, in case of colorless quartz crystal sample and 500°C in case of smoky quartz crystal sample. On the other hand γ-irradiation effect produces many structural changes as revealed by the disappearance, appearance and/or shift of some of the I.R. bands.

To sum up from both the semi quantitative x-ray fluorescence analysis as a fourth technique and the quantitative