APPRAISAL OF HEAT TREATMENT OF *"GEUDA"* GEMSTONES USING GAS-FIRED AND ELECTRICALLY OPERATED FURNACE

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Abstract

"Geuda" gemstones are less valuable corundum variety that has the potential to alter into blue sapphire. *"Geuda"* is found abundantly in Sri Lanka and it is translucent to opaque corundum with a milky or silky appearance in reflected light and brownish honey colour (or diesel colour) in transmitted light with a basic body colour of a bluish, yellowish or reddish colour. At present, Sri Lankan gem industry commonly adapts gas-fired furnaces for heat-treating *"Geuda"*, to obtain the desired blue colour, yet recently introduced electric furnaces have also shown potential. It is widely believed that electric furnaces are superior to gas furnaces in achieving the anticipated colour, yet no proper evaluation has been done in this regard. Thus, revealed the optimum conditions and the colouring mechanism for electric furnace heat treatment compare to gas furnace heat treatment, twenty (20) *"Geuda"* samples were selected and each stone is cut into three similar pieces to compare the colour changes more accurately. The *"Lakmini"* furnace was used as the gas furnace and the maximum chamber temperature used was 1750^{o}C with a soaking time of 30 min under reducing environmental condition inside the gas furnace. Electric heat treatment carried out at three different temperatures (1300^{o}C, 1500^{o}C,1700^{o}C) and with different soaking times (three days, five days, ten days and one month). Colour enhancement after heat treatment was observed using the GIA colour grading system. Samples were subjected to XRD, FTIR and UV-visible spectrum analysis before and after the heat treatments and XRF for the identification of elements present in the gemstones.

The optimum colour alteration occurred in combined heat treatment (1700^{o}C in electrically operated furnace after gas furnace at 1750^{o}C, 30 min). There was a significant peak height drop at 3309 cm^{-1} in FTIR spectroscopy after the thermal treatment in all samples tested. This peak height drop corresponded to O-H stretching mode water molecules inside *"Geuda"* stone and it was imperceptible with one month of soaking time. The UV-Visible analysis showed a peak development after heat treatments at 550 nm-650 nm. This is due to the development of blue colour inside the stone as a result of the formation of $[FeTi]^{+6}$ complex and it was conspicuous in combined heat treatment. d-spaces of the lattice structure in the *"Geuda"* stones have changed in the stones when analyzed using XRD. XRF analysis emphasized that the Fe:Ti ratio is a critical determiner of blue colour development with combine heat treatment. Geuda stones with a Fe:Ti ratio of 1:7 to 1: 13 produced the desired blue colour. Presence of increased Ti in the stone produced a dark blue colour. The results reported in this study suggest the method of heat treatment, Fe:Ti ratio of the stones and reduced environment inside the furnace are the critical determiners of blue colour development in geuda gemstones.

Key Words: "Geuda" Heat treatment, "Geuda", Gemstone Enhancement, Gemstone Characterization

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Table of contents

List of Figures

List of tables

List of abbreviations

UN - Unheated

GH - Gas Heated

EH - Electrically operated furnace heated

CH - Combined Heated (Electrically operated furnace heated after gas heated)

XRF - X-ray Fluorescence

XRD - X-ray Diffraction

FTIR - Fourier-Transform Infrared Spectroscopy

UV-Visible Spectroscopy - Ultraviolet-Visible Spectroscopy

LPG - Liquid Petroleum Gas

GIA - Gemmological Institute of America

^{o}C - Celsius

nm - nanometre

Å - Angstrom

cm^{-1} - Per centimetre

B.C – before Christ