

HPHT treatment of CO₂ containing and CO₂-related brown diamonds [☆]

Thomas Hainschwang ^{a,b,*,1,2}, Franck Notari ^{b,c,2}, Emmanuel Fritsch ^{d,3}, Laurent Massi ^{d,e,3,4}, Benjamin Rondeau ^{e,3}, Christopher M. Breeding ^{f,5}, Heiner Vollstaedt ^{g,6}

^a Gemlab, Gewerbestrasse 3 9496 Balzers, Liechtenstein

^b GIA Switzerland 2, Rue de Chantepoulet 1201 Geneva, Switzerland

^c Gemtechlab 2, Rue de Chantepoulet 1201 Geneva, Switzerland

^d I.M.N. Institut des Matériaux Jean Rouxel LPMN – Nantes 2 rue de la Houssinière - BP 32229, 44322 Nantes Cedex 3 France

^e AIGS Asian Institute of Gemological Sciences Jewelry Trade Center, North Tower 6th Floor, Silom Road, Bangrak Bangkok 10500, Thailand

^f GIA Laboratory 5355 Armada Drive Carlsbad, California 92008

^g AphroDiamante GmbH Pappelallee 29 14554 Seddiner See

Received 20 February 2007; received in revised form 4 January 2008; accepted 7 January 2008

Available online 17 January 2008

Abstract

Ten type I diamonds containing CO₂ and three diamonds related to these (referred to as “Pseudo CO₂” diamonds) were treated by the HPHT process to observe changes in colour, colour distribution, inclusions, luminescence and spectral features in the visible to the mid-infrared regions. All samples were of predominantly brown colour before the treatment and had rather inhomogeneous colour distribution not related to strain like in classic type Ia brown diamonds. Upon HPHT treatment most of them changed to a more yellow hue, with a greenish modifying colour, but the dominant colour was still brown. The modification of colour was found to be much more discreet than it is the case for deformation-related type Ia brown diamond and the colour was not at all related to known centers such as H3. The colour modifications were caused by the destruction of broad absorption bands in the Vis–NIR spectrum by the HPHT process and generally increased transmission from 400 to 700 nm, likely related to a slight increase in single nitrogen, but no typical HPHT annealing related colour centers such as H3 and H2 were produced in the spectra of the samples. This could be confirmed by the luminescence when excited by shortwave and longwave UV light, under which all samples showed a yellow emission that was practically not modified by the treatment.

The infrared spectra of the 10 CO₂ diamonds, defined by the presence of at least the CO₂ stretching (ν_3) and bending (ν_2) absorptions, were unusually modified by the HPHT treatment: the treatment caused the CO₂ bands to increase in intensity in diamonds with low to medium CO₂ content, and the apparently diminished the intensity of the nitrogen-related one phonon absorptions (when present). In the spectra of the three “Pseudo CO₂” samples, which lack by definition the CO₂ peaks, the CO₂ peaks were created and the one phonon absorption reduced by the treatment. The photoluminescence spectra exhibiting several unpublished emission peaks remained practically unchanged by HPHT processing: none of the emissions were annealed out and no new centers created.

[☆] This paper appears to be the first experimental demonstration of the likely presence of structurally bound oxygen in diamond; based on this, for the first time CO₂ absorptions in diamond are proposed to be due to CO₂ molecules structurally bound to the diamond lattice. A novelty is also the presentation of detailed HPHT data for such brown diamonds and the conclusion of this being a “non-identifiable treatment” in this particular case.

* Corresponding author. Gemlab, Gewerbestrasse 3, 9496 Balzers, Liechtenstein. Tel.: +423 262 24 64.

E-mail addresses: thomas.hainschwang@gemlab.net (T. Hainschwang), franck.notari@gemtechlab.ch (F. Notari), emmanuel.fritsch@cnrs-immn.fr (E. Fritsch), hirolithe@hotmail.com (L. Massi), benjamin.rondeau@univ-nantes.fr (B. Rondeau), christopher.breeding@gia.edu (C.M. Breeding), HVollstaedt@aol.com (H. Vollstaedt).

¹ Tel.: +423 262 24 64.

² Tel.: +41 (0) 22 731 58 80.

³ Tel.: +33 (0) 2 40 37 39 74.

⁴ Tel.: +662 267 4325 7.

⁵ Tel.: +1 760 603 4500.

⁶ Tel.: +49 33205 2 20 32.