Abstract: A method and apparatus for labeling plant products based on laser activation of a color-changing compound is disclosed. In the preferred embodiment, a nozzle sprays a coating of photosensitive material containing color-changing chemical component. An optional drying station is set up to optimize homogeneity and adhesiveness of the color-changing coating. A laser equipped with beam steering optics is used to image the desired mark on the plant product by inducing a change of color in the photosensitive coating, without contacting the plant product skin and at a high speed. An optional nozzle sprays a sealant coating after printing, for extended durability of the imaged label. In addition, an optical sensor detects the incoming plant product, determines its size and sends information for selecting the proper label to be imaged. An additional optical sensor can be placed at the end of the process to verify the quality and legibility of the imaged label. The apparatus described can be extended to multiple marking stations, which can be controlled by a central computer to allow for dynamic updating of the desired label(s).
# INTERNATIONAL SEARCH REPORT

## A  CLASSIFICATION OF SUBJECT MATTER

**IPC**  

**USPC**  
219/121 69.347/256,209/3 3

According to International Patent Classification (IPC) or to both national classification and IPC

## B  FIELDS SEARCHED

**Minimum documentation searched (classification system followed by classification symbols)**  
U S 219/121 69, 347/256, 209/3 3

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Please See Continuation Sheet

## C  DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>JOHNSON, M Automation in citrus sorting and packing. Agrotechnation 1 Proceedings of the Agrotechnation 1 conference and exposition (1985), pages 63-68, entire document</td>
<td>1-4, 7, 9, 12, 15, and 31</td>
</tr>
<tr>
<td>Y</td>
<td>US 6,888,095 (KHAN, N ) 03 May 2005 (03 05 2005), entire document</td>
<td>1-4, 7, 9, 12, 15, and 31</td>
</tr>
<tr>
<td>A</td>
<td>CROWE et al. Real-time defect detection in fruit - Part I Design concepts and development of prototype hardware Transactions of the ASAE (1996) Vol 30, pages 2299-2308</td>
<td>1-4, 7, 9, 12, 15, and 31</td>
</tr>
<tr>
<td>A</td>
<td>LEE MANS et al. Vision artificielle et quantification de la forme de pommes Cashiers Agricultures (1997) Vol 6, pages 597-603</td>
<td>1-4, 7, 9, 12, 15, and 31</td>
</tr>
</tbody>
</table>

- **Special categories of cited documents**  
  - **"A"** document defining the general state of the art which is not considered to be of particular relevance
  - **"E"** earlier application or patent published on or after the international filing date
  - **"L"** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  - **"O"** document referring to an oral disclosure, use, exhibition or other means
  - **"P"** document published prior to the international filing date but later than the priority date claimed

- **Special categories of cited documents**  
  - **"I"** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  - **"X"** document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  - **"Y"** document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  - **"W"** document member of the same patent family

**Date of the actual completion of the international search**  
27 August 2008 (27 08 2008)

**Date of mailing of the international search report**  
17 SEP 2008

Name and mailing address of the ISA/US  
Mail Stop PCT, Attn: ISA/US  
Commissioner for Patents  
P O Box 1450  
Alexandria, Virginia 22313-1450

Facsimile No (571) 273-3201

Form PCT/ISA/210 (second sheet) (April 2007)
**INTERNATIONAL SEARCH REPORT**

**Box No. II  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. **LJ** Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. [ ] Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically

3. [ ] Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 64(a).

**Box No. III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of any additional fees.

3. **LAJ** As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.: 1-4, 7, 9, 12, 13 and 31

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

   **Remark on Protest**
   [X] The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
   [ ] The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
   [ ] No protest accompanied the payment of additional search fees.
BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claim(s) 1, 2, and 13, drawn to a method for labeling plant products by conveying the products to plural locations, detecting the products, applying a coating of a color change compound on at least a portion of a surface of the plant product, and selectively applying light to at least a portion of the surface coated with the color changing compound, including wherein said method further comprises applying a coat of sealant material over the portion of the product.

Group II, claim(s) 1, 3, 4, 9, 12, and 13, drawn to a method for labeling plant products by conveying the products to plural locations, detecting the products, applying a coating of a color change compound on at least a portion of a surface of the plant product, and selectively applying light to at least a portion of the surface coated with the color changing compound, including wherein said method further comprises verifying the quality of an image created by the light.

Group III, claim(s) 1, 5, and 13, drawn to a method for labeling plant products by conveying the products to plural locations, detecting the products, applying a coating of a color change compound on at least a portion of a surface of the plant product, and selectively applying light to at least a portion of the surface coated with the color changing compound, including wherein said plant product is a citrus fruit, a non-citrus fruit, a vegetable, or a legume.

Group IV, claim(s) 1, 6, and 13, drawn to a method for labeling plant products by conveying the products to plural locations, detecting the products, applying a coating of a color change compound on at least a portion of a surface of the plant product, and selectively applying light to at least a portion of the surface coated with the color changing compound, including wherein said method further comprises supplying a plurality of plant products to a common conveying mechanism and transporting the plant product serially on said common conveying mechanism at a constant or variable speed.

Group V, claim(s) 1, 7, 13, and 3 drawn to a method for labeling plant products by conveying the products to plural locations, detecting the products, applying a coating of a color change compound on at least a portion of a surface of the plant product, and selectively applying light to at least a portion of the surface coated with the color changing compound, including wherein said method further comprises detection by size, color, quality, orientation, type, or texture.

Group VI, claim(s) 1, 8, and 13, drawn to a method for labeling plant products by conveying the products to plural locations, detecting the products, applying a coating of a color change compound on at least a portion of a surface of the plant product, and selectively applying light to at least a portion of the surface coated with the color changing compound, including wherein said method further comprises drying the coating.

Group VII, claim(s) 1, 10, 11, and 13, drawn to a method for labeling plant products by conveying the products to plural locations, detecting the products, applying a coating of a color change compound on at least a portion of a surface of the plant product, and selectively applying light to at least a portion of the surface coated with the color changing compound, including wherein said method further comprises selectively applying the light with a steerable laser beam.

Group VIII, claim(s) 14 - 16, and 28, drawn to an apparatus for labeling plant products wherein said apparatus comprises a conveying system, a detection system, a color-changing compound, a marking system, and a control unit, and further comprising a sealant delivery system.
INTERNATIONAL SEARCH REPORT

Group IX, claim(s) 14, 17, 19, 20, 29, and 30, drawn to an apparatus for labeling plant products wherein said apparatus comprises a conveying system, a detector, a color changing compound, a marking system, and a control unit, and further comprises an image detecting system coupled to said control system, for recognition of the image and assigning an encoded instruction for redirection

Group X, claim(s) 14 and 18, drawn to an apparatus for labeling plant products wherein said apparatus comprises a conveying system, a detector, a color changing compound, a marking system, and a control unit, wherein said conveying system is operative to transport each plant product at a constant speed, to provide an encoded signal for plant product location, and further comprises means for ejecting the plant product at a specific location

Group XI, claim(s), 14 and 21, drawn to an apparatus for labeling plant products wherein said apparatus comprises a conveying system, a detector, a color changing compound, a marking system, and a control unit, wherein the control unit generates an image of at least a part of the plant product

Group XII, claim(s) 14 and 22, drawn to an apparatus for labeling plant products wherein said apparatus comprises a conveying system, a detector, a color changing compound, a marking system, and a control unit, and further comprises a network for communication with plural system components

Group XIII, claim(s) 14 and 23, drawn to an apparatus for labeling plant products wherein said apparatus comprises a conveying system, a detector, a color changing compound, a marking system, and a control unit, wherein the color changing compound delivery system comprises a spraying nozzle, a brush, or a contact applicator

Group XIV, claim(s) 14 and 24, drawn to an apparatus for labeling plant products wherein said apparatus comprises a conveying system, a detector, a color changing compound, a marking system, and a control unit, wherein said color changing compound delivery system further comprises a pressurized system

Group XV, claim(s) 14 and 25, drawn to an apparatus for labeling plant products wherein said apparatus comprises a conveying system, a detector, a color changing compound, a marking system, and a control unit, wherein said plant product is a citrus fruit, a non-citrus fruit, a vegetable, a legume, or like

Group XVI, claim(s) 14 and 26, drawn to an apparatus for labeling plant products wherein said apparatus comprises a conveying system, a detector, a color changing compound, a marking system, and a control unit, wherein the marking system comprises a laser of the CO2 type emitting at substantially 10600nm

Group XVII, claim(s) 14 and 27, drawn to an apparatus for labeling plant products wherein said apparatus comprises a conveying system, a detector, a color changing compound, a marking system, and a control unit, wherein the marking system comprises a laser equipped with steering-beam optics

Group XVIII, claim(s) 1, 13, and 18, drawn to a method for labeling plant products by conveying the products to plural locations, detecting the products, applying a coating of a color change compound on at least a portion of a surface of the plant product, and selectively applying light to at least a portion of the surface coated with the color change compound, including wherein said method further comprises modifying the color changing compound to achieve optimal viscosity and particle size

Group XIX, claim(s) 14 and 33, drawn to an apparatus for labeling plant products wherein said apparatus comprises a conveying system, a detector, a color changing compound, a marking system, and a control unit, and further comprises a detector system for determining the size, texture, and shape of a plant product, and farther comprises an adjustment unit coupled to the marking system

The inventions listed as Groups I-XIX do not relate to a single general inventive concept under PCT Rule 13 1 because, under PCT Rule 13 2, they lack the same or corresponding special technical features for the following reasons

The technical feature linking the inventions of Groups I-XIX is a method of labeling a plant product utilizing a color change compound. However, in the prior art (Cahiers Agricultures (1997) Vol 6, pp 597-603) Leemans et al teach a method of inspecting apples for color, shape, and presence of defects that utilizes machine vision and a conveyor belt and CCD cameras (see English abstract on page 600) Also in the prior art (US Patent 6,888,095, issued on May 3, 2005) Khan teaches the use of color change compounds that change after laser treatment and are appropriate for labeling edible material (see abstract and entire document) It does not involve an inventive step to incorporate the color change compounds taught by Khan into the plant product inspection system taught by Leemans et al to arrive at a system that utilizes conveyor belts to sort and label plant products, such as fruit Therefore, the technical feature linking the inventions of Groups I-XIX does not constitute a special technical feature as defined by PCT Rule 13 2 as it does not define a contribution over the prior art Accordingly, Groups I-XIX are not so linked by the same or a corresponding special technical feature as to form a single general inventive concept

Form PCT/ISA/210 (extra sheet) (April 2007)
Continuation of B. FIELDS SEARCHED Item 3:
STN Search of Agricola, Biosis, and Caplus databases; Google search; WEST Search of Patent Databases.
Search terms: fruit, vegetable, produce, conveyor belt, sorting, sort, automate, automated, laser, table