CERAMIC TAGGANTS FOR AUTHENTICATION OR PROVENANCE MARKING OF ELECTRONIC COMPONENTS

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CERAMIC TAGGANT TECHNOLOGY

- DatadotUSA and Arthur Jonath Associates
- Materials
- Detection
- Security Features
- Deployment
- Authenticity/Provenance Verification
- Applications

CERAMIC TAGGANT TECHNOLOGY

TEAM

- **DataDot Technology USA, Inc. (subsidiary of Datatrace, an Australian company**
  - **security company supplying practical taggant technologies for anti-counterfeiting and security applications**

- **Arthur Jonath Associates (AJA)**
  - **technology transfer consulting group, advising in counterfeit analysis and avoidance measures**

CERAMIC TAGGANT TECHNOLOGY

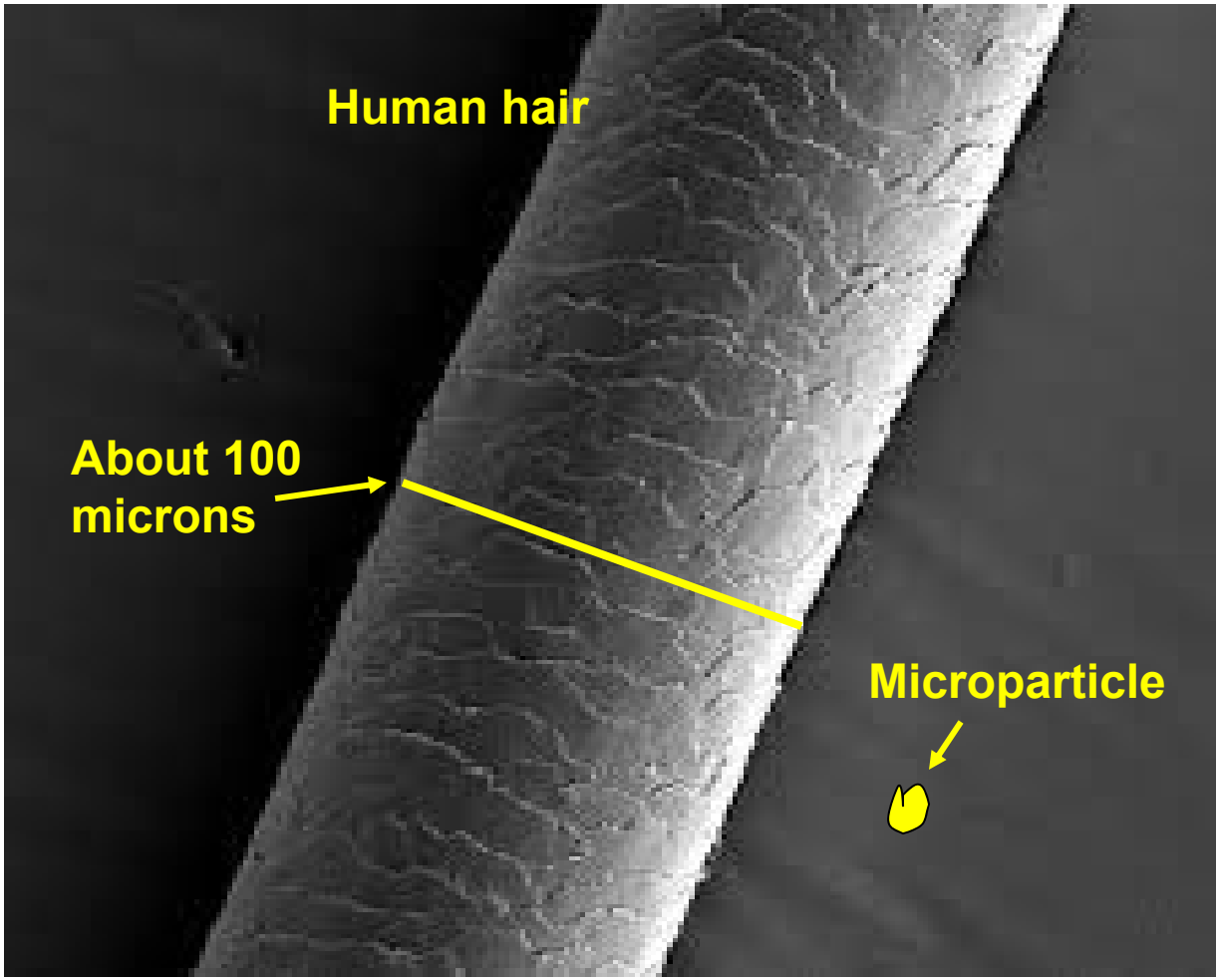
MATERIAL

WHAT ARE CERAMICS?

- From the Greek, “keramikos” = pottery
- Inorganic, nonmetallic solids
- Blended and processed into the microparticle range, 4-12 microns in size

CERAMIC TAGGANT TECHNOLOGY
MATERIAL

- **Taggant comprises proprietary formulations of *ceramic micro-particles*, typically 4 - 12µm**



CERAMIC TAGGANT TECHNOLOGY

MATERIAL

CERAMICS ARE ROBUST IN HARSH ENVIRONMENTS

- Unaffected by temperatures to 1000C
- Inert to chemical attack by acids, alkalis, solvents, water, humidity, and steam
- Inert to biological or fungal attack
- Inert to UV, solar, IR, and X-ray irradiation
- Dispersed but not altered by detonation

TAGGED PWB COULD HAVE BEEN TRACED IMMEDIATELY

CERAMIC TAGGANT TECHNOLOGY
MATERIAL

- **Ceramic taggants contain proprietary tracer materials**
- **Tracers are formulated to deliver unique identifying information that is read when the taggant is properly “queried”**
- **Composition of ceramic tracers makes them virtually impossible to chemically copy to reproduce or extract the embedded security information**

CERAMIC TAGGANT TECHNOLOGY

MATERIAL

Rare earth phosphors, for example:

$Y_2O_3:Eu^{3+}$

$CeMgAl_{11}O_{19}:Tb^{3+}$

$BaMgAl_{10}O_{17}:Eu$

$La_{0.60}Ce_{0.27}Tb_{0.13}PO_4$

$GdMgB_5O_{10}:Ce, Tb$

$(Sr,Ba,Ca)_5(PO_4)3Cl:Eu^{2+}$

HEAVY Rare Earth Elements

LIGHT Rare Earth Elements

by Geology.com

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La-Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac-Lr	Rf	Db	Sg	Bh	Hs	Mt									

Lanthanides

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu

Actinides

Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

CERAMIC TAGGANT TECHNOLOGY
MATERIAL

RARE EARTHS

- They are not really “rare”--- 200x or more higher concentration in the earth than gold
- They are “rare” because of the difficulty in extracting from ore.
- Their usage is not “rare”; 124,000 tons in 2009.

Metallurgy	29%	Catalytic converters	9%
Electronics	18%	Glass polishing	8%
Catalysts	14%	Permanent magnets	5%
Phosphors (TV, lights)	12%	Oil refining	4%


Scandium

CERAMIC TAGGANT TECHNOLOGY

HOW IT COMES TOGETHER

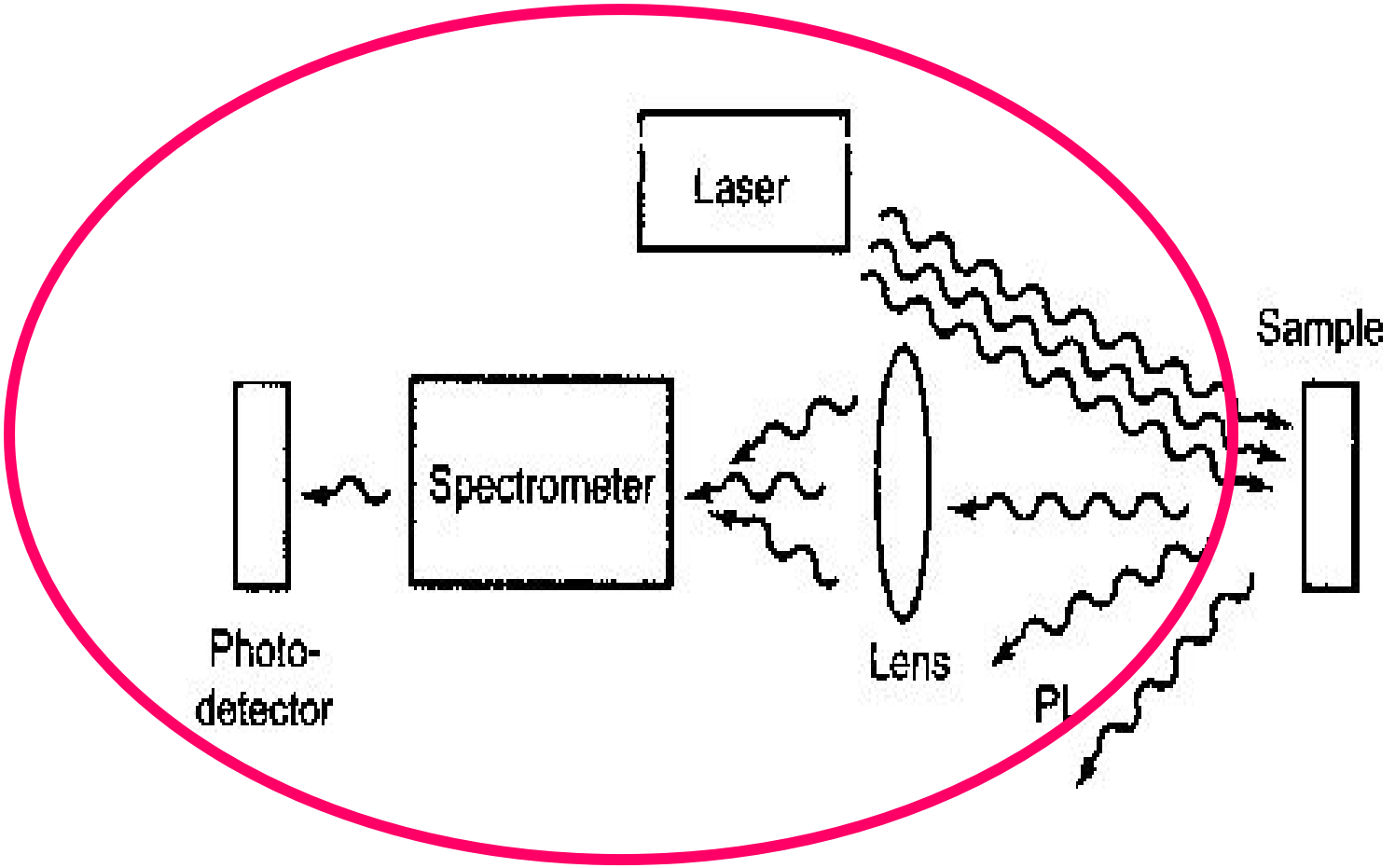
- **Acquire uncommon ceramic materials containing rare earth compounds with light-activated properties**
- **Blend these materials into specific formulations**
- **Customize the formulations for integration into customer's manufacturing process**
- **Customize the formulations for application to customer's goods**
- **Program the reader to the formulations customized for each individual customer's product using complex and variable detection algorithms for processing the light emissions from the taggant**

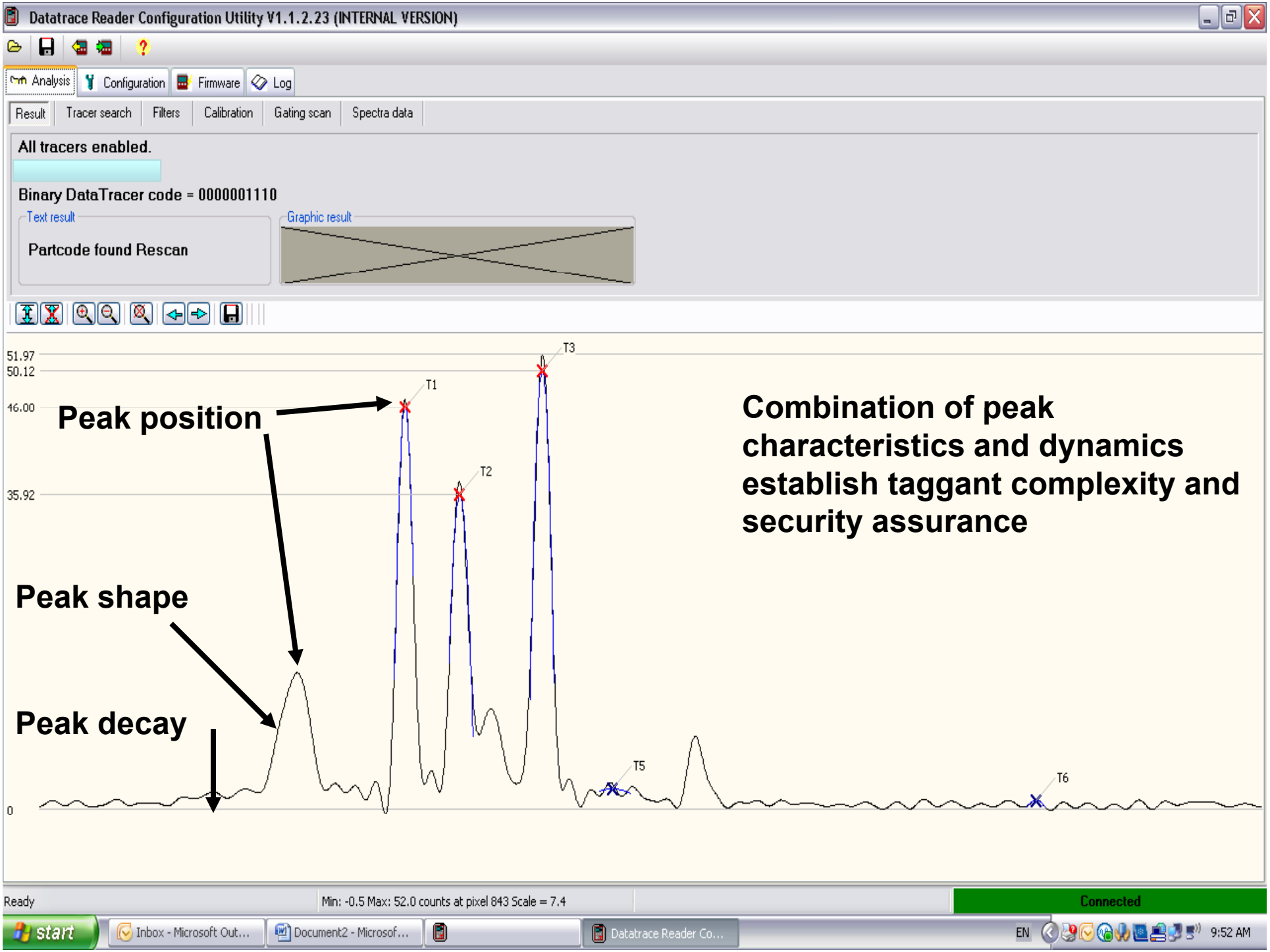
CERAMIC TAGGANT TECHNOLOGY
DETECTION

Taggant materials are formulated to respond by photoluminescence upon optical excitation

CERAMIC TAGGANT TECHNOLOGY
DETECTION

Photoluminescence: photons striking a material "excite" the atoms in the material causing them to emit other photons at various wavelengths




Datatrace Reader Configuration Utility V1.1.2.23 (INTERNAL VERSION)
Analysis
Configuration
Firmware
Log
Result
Tracer search
Filters
Calibration
Gating scan
Spectra data
All tracers enabled.
Binary DataTracer code = 0000001110
Text result
Partcode found Rescan
Graphic result
51.97
50.12
46.00
35.92
0
T1
T2
T3
T5
T6
Peak position
Peak shape
Peak decay
Combination of peak characteristics and dynamics establish taggant complexity and security assurance
Ready
Min: -0.5 Max: 52.0 counts at pixel 843 Scale = 7.4
Connected
start
Inbox - Microsoft Out...
Document2 - Microsof...
Datatrace Reader Co...
EN
9:52 AM

CERAMIC TAGGANT TECHNOLOGY
DETECTION

- **Particular tracer compounds in ceramic taggants *luminesce* under excitation from a handheld reader**
- **The reader collects and spectrally analyzes photons from taggant luminescence**
- **Readers are pre-programmed with complex detection algorithms to process the spectra**
- **Combination of spectral signatures from ceramic formulation, and recognition of this information by detection algorithms in the reader, confirms authenticity of tagged objects**
- **Tagged objects are authenticated *IN SITU* and *IN SECONDS***

CERAMIC TAGGANT TECHNOLOGY
SECURITY FEATURES

- **Robust ceramic taggant materials**
- **Proprietary encoding in tracer materials**
- **Complex spectral luminescence**
- **Response only at selected excitation wavelengths**
- **Variable detection algorithms**
- **Algorithmic modification selected and known only by the user**
- **Complex combination of material formulation and reader algorithms gives virtually unbreakable code**

CERAMIC TAGGANT TECHNOLOGY

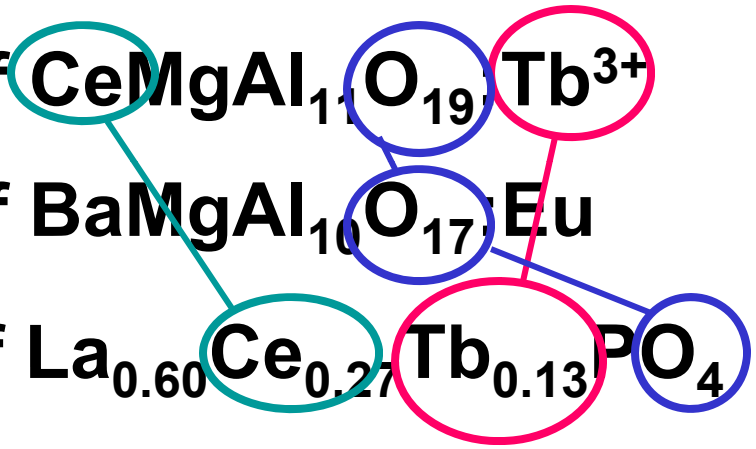
SECURITY FEATURES

Consider a blend of:

x grams of $CeMgAl_{11}O_{19}:Tb^{3+}$

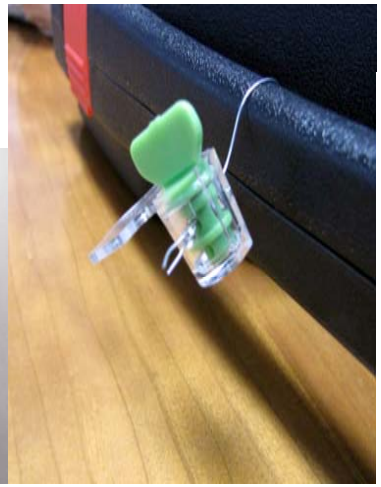
y grams of $BaMgAl_{10}O_{17}:Eu$

z grams of $La_{0.60}Ce_{0.27}Tb_{0.13}PO_4$



CERAMIC TAGGANT TECHNOLOGY
DEPLOYMENT

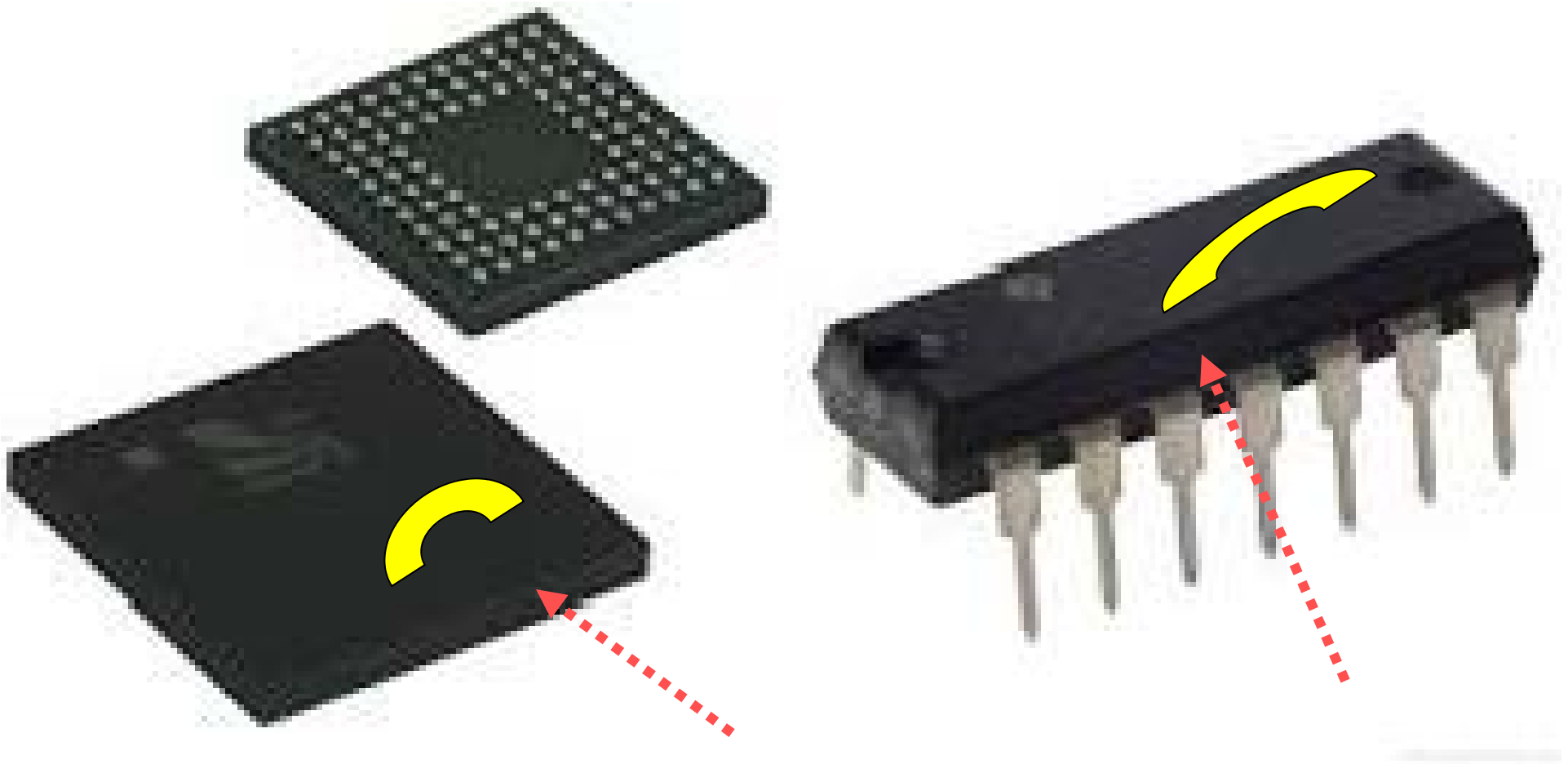
- Taggants can be incorporated as minor or trace ingredients in
  - Polymers (bulk or films)
  - Inks
    - For conventional printing
    - Thermal transfer technology
  - Conformal coatings
  - Adhesives
  - Permanent, hard wearing coating on glass, metal, and plastic
  - Metal plating technologies
- Other means of deployment
  - Security stickers
  - Polymer seals
  - Spray-on
  - Marking pens



CERAMIC TAGGANT TECHNOLOGY

DEPLOYMENT

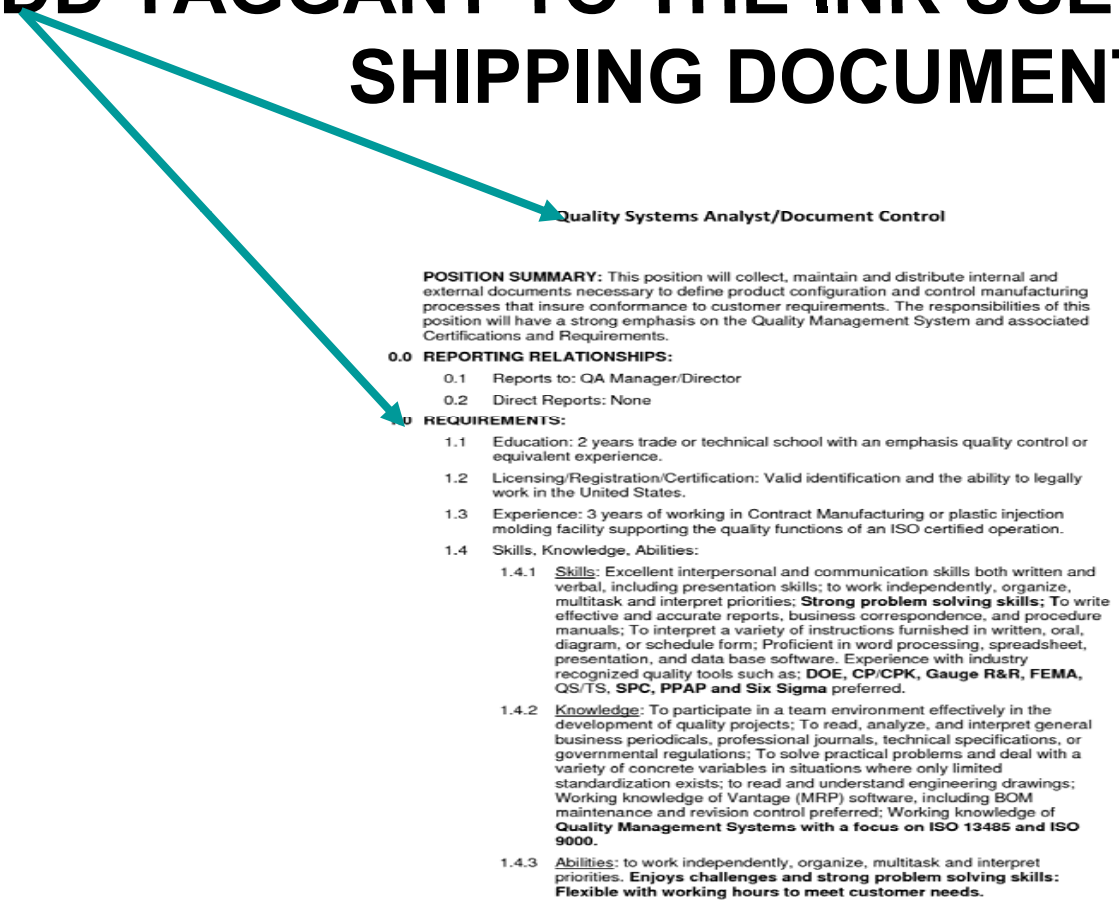
APPLY TAGGANT TO INDIVIDUAL UNITS



CERAMIC TAGGANT TECHNOLOGY

DEPLOYMENT

ADD TAGGANT TO THE INK USED TO PRINT SHIPPING DOCUMENTS



Quality Systems Analyst/Document Control

POSITION SUMMARY: This position will collect, maintain and distribute internal and external documents necessary to define product configuration and control manufacturing processes that insure conformance to customer requirements. The responsibilities of this position will have a strong emphasis on the Quality Management System and associated Certifications and Requirements.

0.0 REPORTING RELATIONSHIPS:

0.1 Reports to: QA Manager/Director

0.2 Direct Reports: None

1.0 REQUIREMENTS:

1.1 Education: 2 years trade or technical school with an emphasis quality control or equivalent experience.

1.2 Licensing/Registration/Certification: Valid identification and the ability to legally work in the United States.

1.3 Experience: 3 years of working in Contract Manufacturing or plastic injection molding facility supporting the quality functions of an ISO certified operation.

1.4 Skills, Knowledge, Abilities:

1.4.1 Skills: Excellent interpersonal and communication skills both written and verbal, including presentation skills; to work independently, organize, multitask and interpret priorities; **Strong problem solving skills;** To write effective and accurate reports, business correspondence, and procedure manuals; To interpret a variety of instructions furnished in written, oral, diagram, or schedule form; Proficient in word processing, spreadsheet, presentation, and data base software. Experience with industry recognized quality tools such as; **DOE, CP/CPK, Gauge R&R, FEMA,** QS/TS, **SPC, PPAP and Six Sigma** preferred.

1.4.2 Knowledge: To participate in a team environment effectively in the development of quality projects; To read, analyze, and interpret general business periodicals, professional journals, technical specifications, or governmental regulations; To solve practical problems and deal with a variety of concrete variables in situations where only limited standardization exists; to read and understand engineering drawings; Working knowledge of Vantage (MRP) software, including BOM maintenance and revision control preferred; Working knowledge of **Quality Management Systems with a focus on ISO 13485 and ISO 9000.**

1.4.3 Abilities: to work independently, organize, multitask and interpret priorities. **Enjoys challenges and strong problem solving skills: Flexible with working hours to meet customer needs.**

CERAMIC TAGGANT TECHNOLOGY

PRODUCT AUTHENTICATION

CERAMIC TAGGANT TECHNOLOGY
PRODUCT AUTHENTICATION

- Can be done by any entry level employee with minimal on-job training
- Tagged objects are field-authenticatable
- No laboratory or database access needed
- Authentication/provenance takes a few seconds
- Can be conducted anytime during storage and service life at any post-manufacture point
  - Outgoing inspection
  - Stores or warehouse
  - Shipping dock
  - Receiving dock
  - Incoming inspection
  - Pre-component installation
  - In-system during service life
  - Post-service inspection or failure analysis

CERAMIC TAGGANT TECHNOLOGY

INDUSTRIAL APPLICATIONS in FORCE

- Industrial bearings
- Pharmaceutical packaging
- Health care product packaging
- Yarn and thread manufacture
- Polymeric casino chips
- Agricultural products; seed authentication
- Electrical utilities, copper theft
- Mining equipment
- Qualified for explosive materials authentication, both pre- and post-detonation
- Qualified for banknote security

Taggants - DNA vs Ceramic

	DNA	Ceramics
Material	Biological DNA	Inorganic compounds
Thermal properties	Vulnerable at higher temps	Inert to >1000C
Chemical properties	Vulnerable to mineral acids, solvents	Chemically inert
Biological properties	Potentially vulnerable to biological attack	Biologically inert
Impinging radiation	Potentially vulnerable to X-ray, laser energy	Inert to all impinging radiation
Authentication test	Destructive to taggant	Non-destructive
Where authenticated	Laboratory	Anywhere, in the field
Time to authenticate	1-3 days+ lab sequencing	Seconds
Security codes	Theoretically, many billions	Theoretically, billions
Copyability/ Breakability	Any organic chemist experienced in sequencing DNA can copy	Virtually impossible; Mixed compound formulations Reader algorithms

CERAMIC TAGGANT TECHNOLOGY
AGENCY/ORGANIZATION AWARENESS

- Responded to Defense Logistic Agency RFI on taggant technology. Awaiting opportunity to present to DLA
- Presented to Jedec G12 anti-counterfeit committee at January 2013 San Antonio meeting
- Presented to SAE G19D anticounterfeit sub-committee
- Described to High Density Packaging User Group, (www.hdpug.org) Anti-Counterfeit Electronics project
- CALCE would like to evaluate

ANTICIPATING YOUR QUESTIONS

- **Why should I care about this?**
  - **Tagging is not my job, OCMs should do it**
- **Why should I care about this?**
  - **You are now informed, should the "supply chain" implement this technology**
- **Should I bother with it?**
  - **Consider offering component or documentation tagging as a value-added feature of your products and services; "mark of provenance"**
- **How much does it cost?**
  - **Datadot is a security technology company. Cost is driven by your unique product/security situation**

FOR MORE INFORMATION

Arthur Jonath Associates

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