

Technology Brief of CityU's IP

Encrypting Anti-counterfeiting Patterns with Multi-Mode Luminescent Nanotaggants (IDF#519, US 15/406,021)

[Ref.: <https://pubs.rsc.org/en/content/articlelanding/2017/NR/C6NR09083D#!divAbstract>]

Encrypting Anti-counterfeiting Patterns with Multi-Mode Luminescent Nanotaggants

Current Anti-counterfeiting Methods:

Overt



Holograms



Color-Shifting Ink

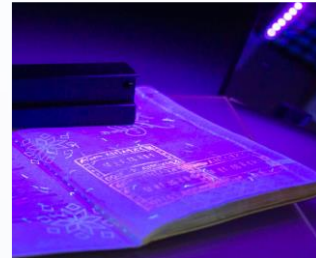


Security Thread



Embossed Shading

Covert



Fluorescent Ink



Polarized hidden Image

Track & Trace



RFID



QR Code



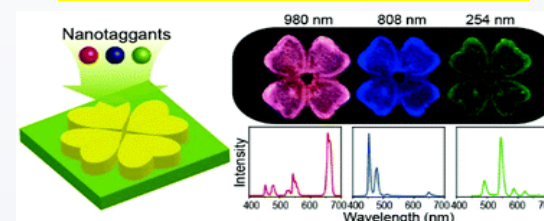
Forensic

Forensic markers

- Chemical taggants: trace chemicals which can only be detected by highly specific reagent system, not by conventional analysis
- Micro taggants: they are microscopic particles containing coded information like alphanumeric data on small flakes or threads, fragments of multicoloured multilayered laminates



Luminescent Nanotaggants



Encrypting Anti-counterfeiting Patterns with Multi-Mode Luminescent Nanotaggants

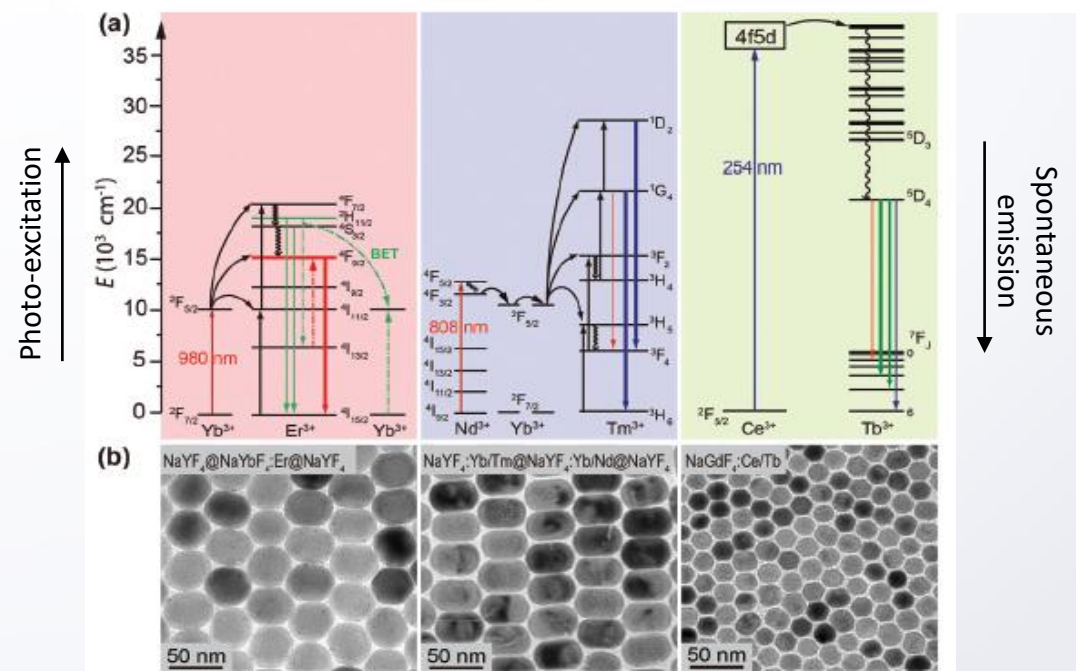
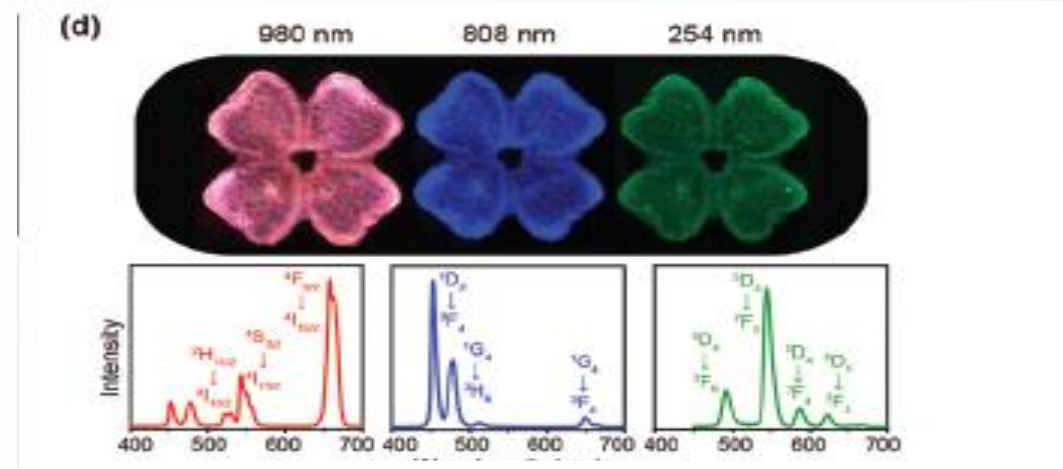
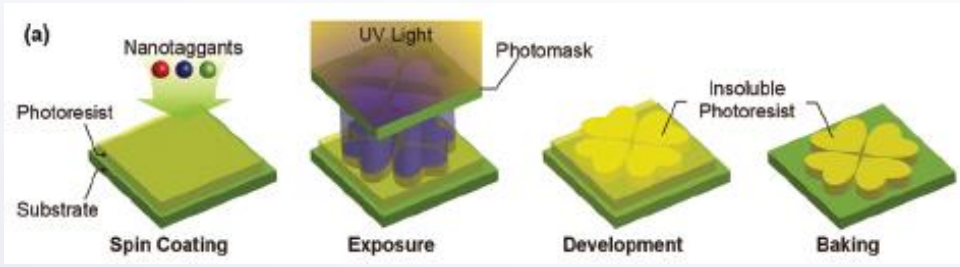
Luminescent Nanotaggants

→ {lanthanide-doped nanoparticle}

Atomic Number
57 - 71

Periodic Table

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
			* 57 La	* 58 Ce	* 59 Pr	* 60 Nd	* 61 Pm	* 62 Sm	* 63 Eu	* 64 Gd	* 65 Tb	* 66 Dy	* 67 Ho	* 68 Er	* 69 Tm	* 70 Yb		
			* 89 Ac	* 90 Th	* 91 Pa	* 92 U	* 93 Np	* 94 Pu	* 95 Am	* 96 Cm	* 97 Bk	* 98 Cf	* 99 Es	* 100 Fm	* 101 Md	* 102 No		

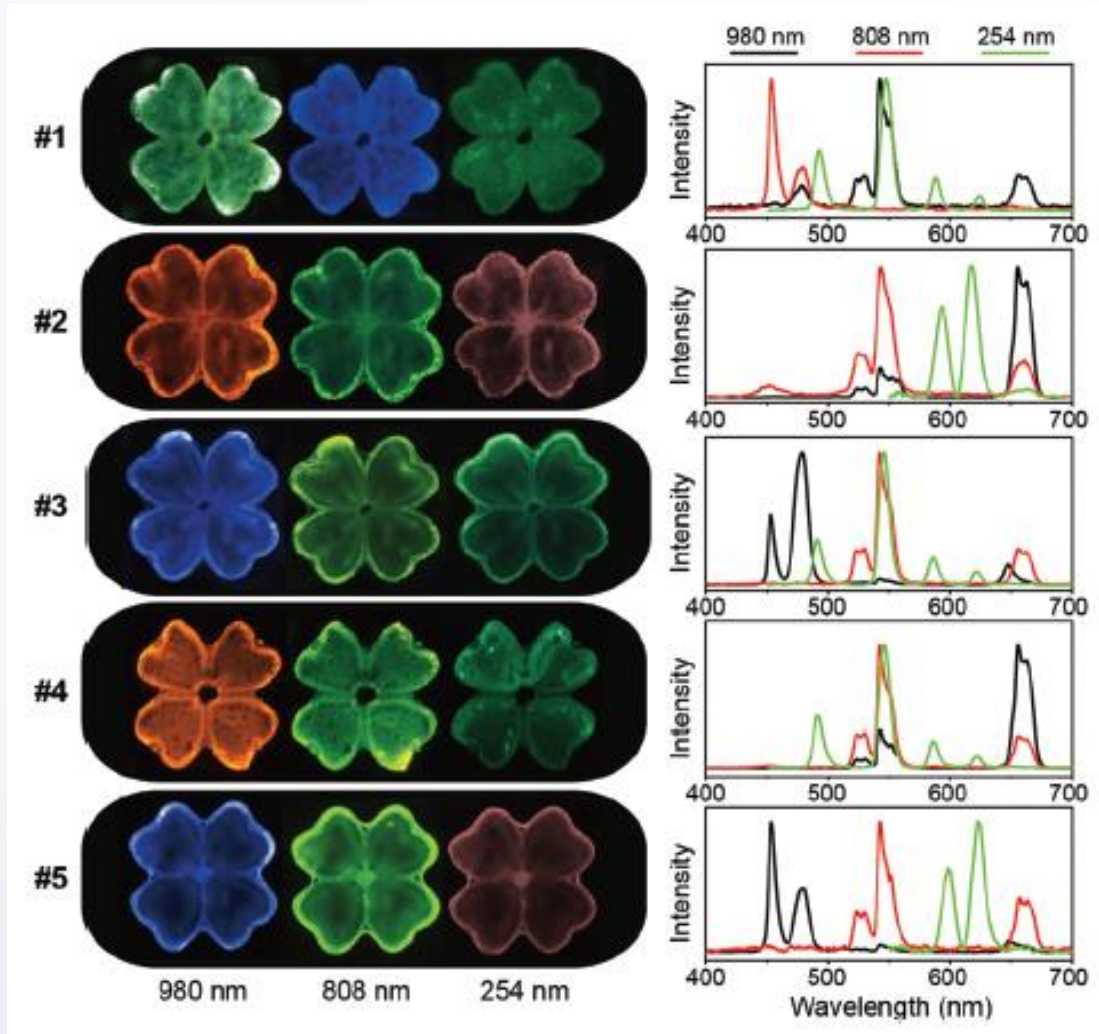


NaYF₄@NaYbF₄:Er@NaYF₄

NaYF₄:Yb/Tm@NaYF₄:Yb/Nd@NaYF₄

NaGdF₄:Ce/Tb

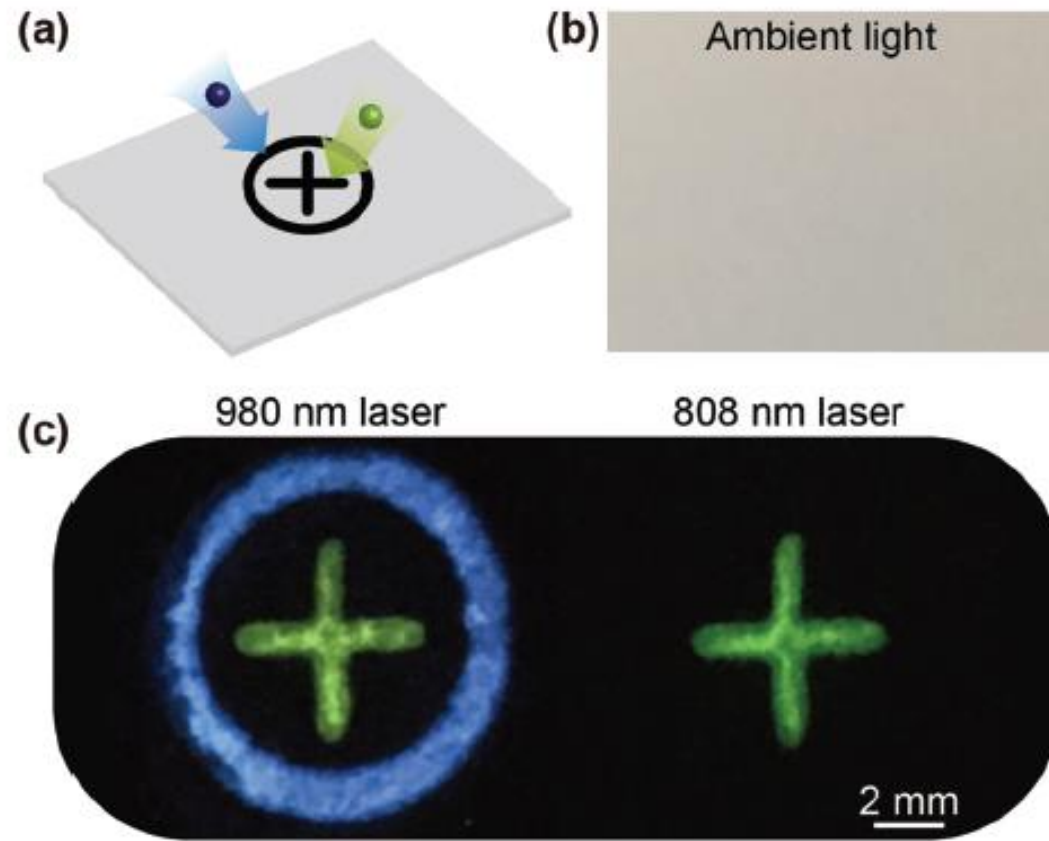
Encrypting Anti-counterfeiting Patterns with Multi-Mode Luminescent Nanotaggants



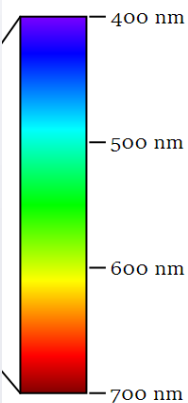
- The color of nanotaggants is tunable through the control of activator composition and concentration of lanthanide elements
 - The unique colour (wavelength) of each Anti-counterfeiting Pattern contains the encrypted information
- Color/graphic sequence for authentication
 - enhance the difficulty of duplicate

The encoding/patterning capacity could be substantially expanded!

Encrypting Anti-counterfeiting Patterns with Multi-Mode Luminescent Nanotaggants



Spectrum of Visible light



- a) Nanotaggants with encrypted lanthanide are coated at the dedicated positions of a single pattern on the substrate
- b) The pattern under ambient light is invisible
- c) It is able to be seen under dedicated color (wavelength) of lighting, such as far IR or UV

→ The Anti-counterfeiting Pattern can be either:

- (i) Read by naked eye (covert)
- (ii) Authenticated with assistance of professional equipment in laboratory (forensic)

Encrypting Anti-counterfeiting Patterns with Multi-Mode Luminescent Nanotaggants

Advantages:

- Nanotaggants Pattern encrypted by Lanthanide with High Security Level
- Anti-counterfeiting Pattern hidden but readable under invisible lighting
- Difficult to duplicate by various nanotaggants on a single pattern or color-graphic sequence
- Pattern feasible on any material substrate

Applications:

- Anti-counterfeiting for Food & Beverages, Pharmaceuticals & Healthcare, Clothing & Accessories,, Industrial & Automotive, Electronic device



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Thank you!

Q & A