

THE USE OF ANTI-STOKES UPCONVERSION POWDERS AND INFRARED LASER FOR FINGERPRINT VISUALIZATION

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Background

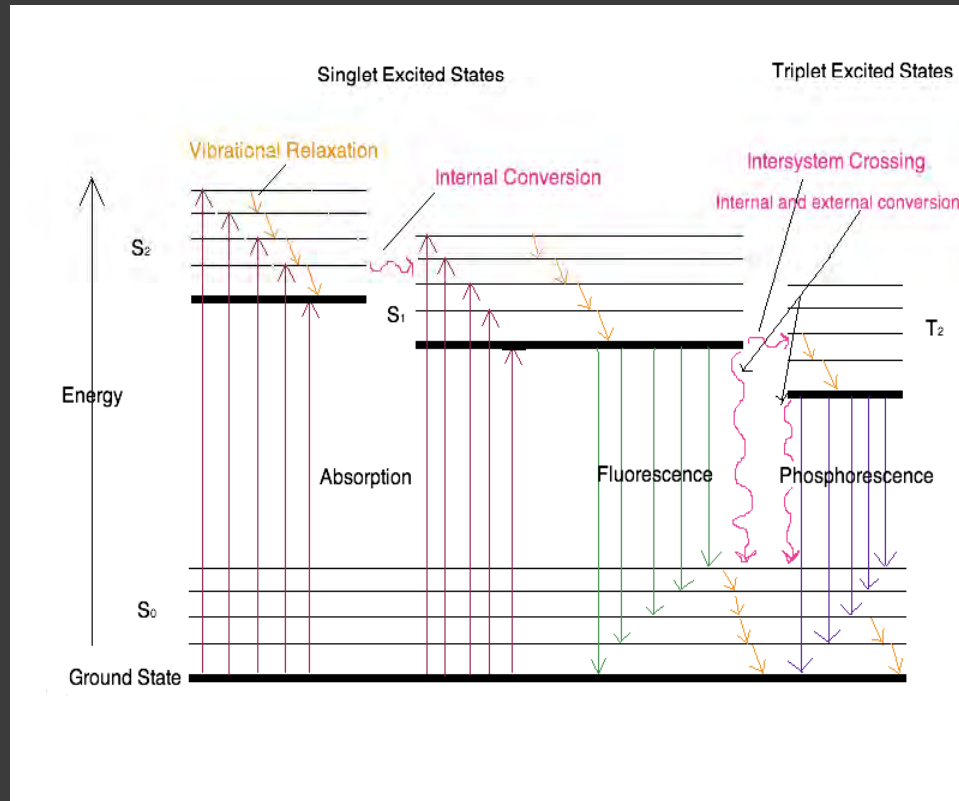
- ① The most commonly used physical method of development is powdering
- ① Powders contain a polymer component and color component
- ① Most commonly used powders include:
 - Black powder (aluminum or carbon)
 - Magnetic powder
 - Fluorescent powder

Background

- ⦿ Some substrates exhibit background luminescence
- ⦿ Includes highly patterned and multicolored items
 - Beverage cans
 - Banknotes
 - Some metals and plastics
 - Glossy magazines or papers
 - Leather

Background

- Remember excited states from chemistry?



Stokes Shift

- Stokes shift occurs when the radiation emits at a longer wavelength than the original excitation wavelength
- Stokes shifts occur as a result of using light sources for illumination

Low λ

High λ

excitation

emission



Anti Stokes Shift

- Recently, focus has shifted to the use of lanthanide metals
- When the metal is complexed with the appropriate ligand, energy levels are tuned to enhance luminescence
- Lanthanides can also exhibit Anti Stokes shifts or upconversion

Caldwell, J. P., Ph.D., Henderson, W., Ph.D., & Kim, N. D., Ph.D. (2001, November). Luminescent Visualization of Latent Fingerprints by Direct Reaction with a Lanthanide Shift Reagent. *Journal of Forensic Sciences*, 46(6), 1332-1341.

Ma, R., Shimmon, R., Maynard, P., Lennard, C., & Roux, C. (2009). *Further Research into Novel Fingerprint Detection Techniques Using Anti-Stokes Luminescence*. Power point presentation presented at University of Technology Sydney.

Current Research

- Little research has been done with upconversion or Anti Stokes type fingerprint powders
- Liu, Zhang et al.
- University of Technology Sydney

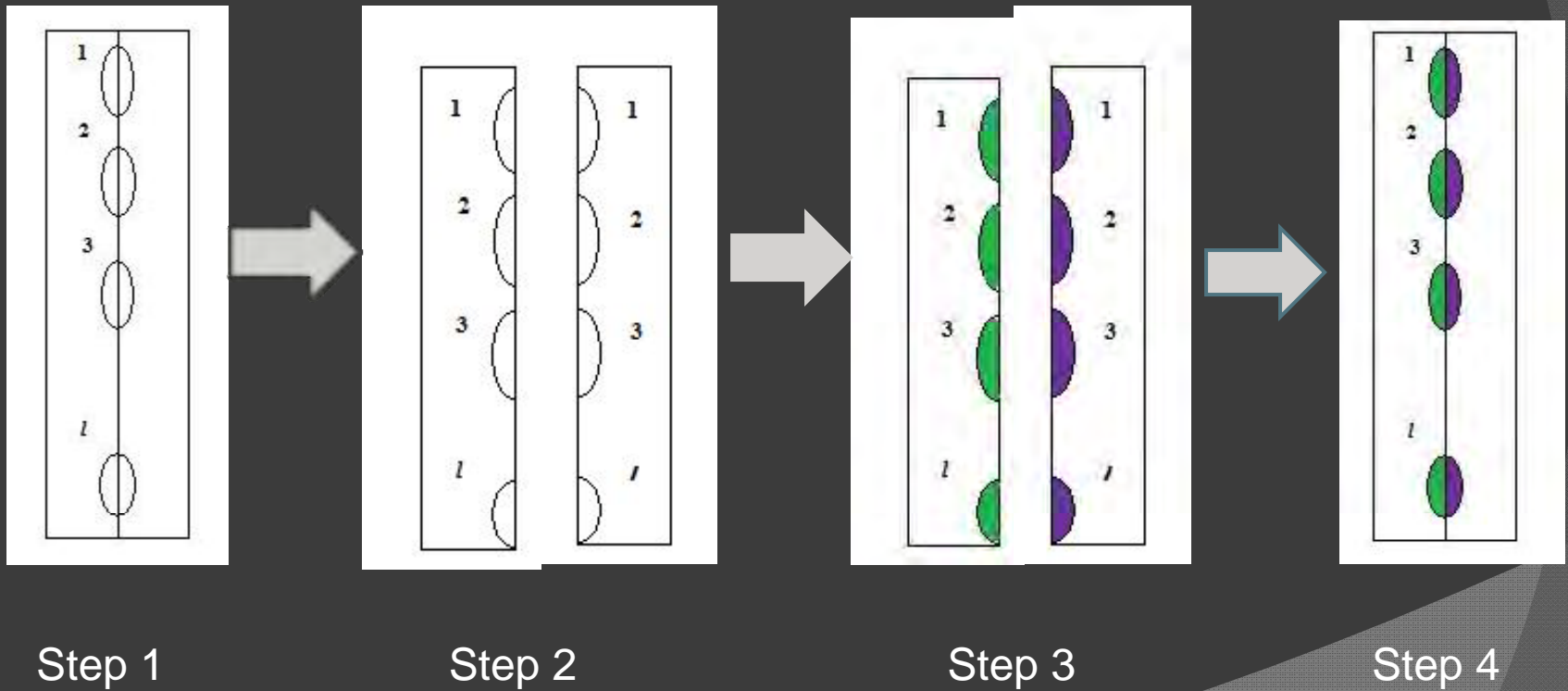
Overall Aim

- To determine if new upconversion fingerprint powders offer any better visualization capability over the traditionally utilized fingerprint powders using an infrared laser.

Methods

- Non porous substrates
- Total of 12 donors volunteered their fingerprints
- Deposited fingerprints using a depletion series onto each substrate
- Allowed to age between 7-30 days

What is a depletion series?

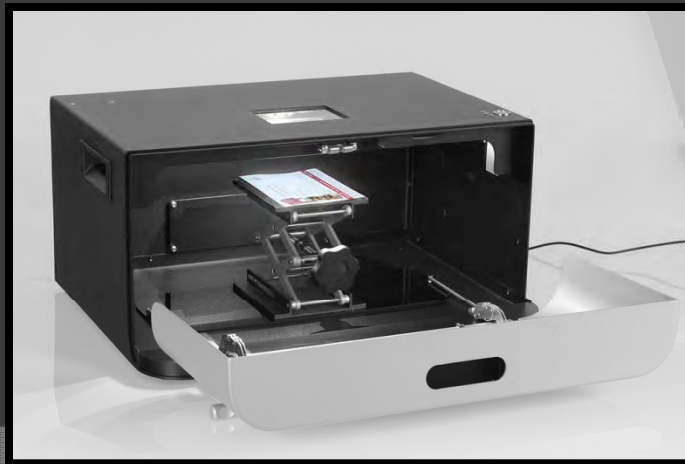


Fingerprint Powders

- Compared the upconversion powder (BVDA International) to:
 - Non-magnetic powders (carbon black and white powder)
 - Magnetic powder (black and white)
 - Green Fluorescent powder (Greenwop)

Light Sources

- Lumatec Superlite 400 light source
 - 320-700 nm
- Crimelite ASL battery-powered laser light source
 - Infrared
 - 6 W laser diode emitting at 976 nm



Photographs

- Foster + Freeman DCS-4 with a Fuji Finepix S2 Pro digital SLR camera
- Non-magnetic and magnetic: white light
- Greenwop: Schott OG550 529 nm orange filter with blue/green light (460-510 nm)
- Upconversion: Schott GG495 476nm yellow filter

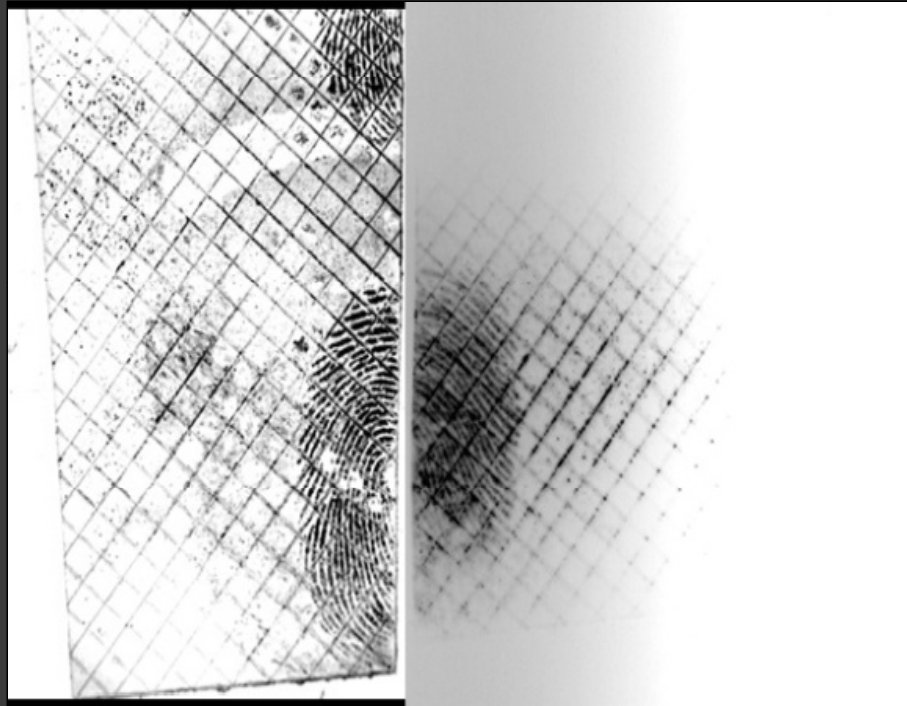
Scanning Electron Microscope

◎ Hitachi SEM S-3500N

- Using high voltage
- Scanned in TV mode
- Images captured in High Resolution mode
- Quartz PCI – Image Management System

Non-magnetic vs. Upconversion

white powder

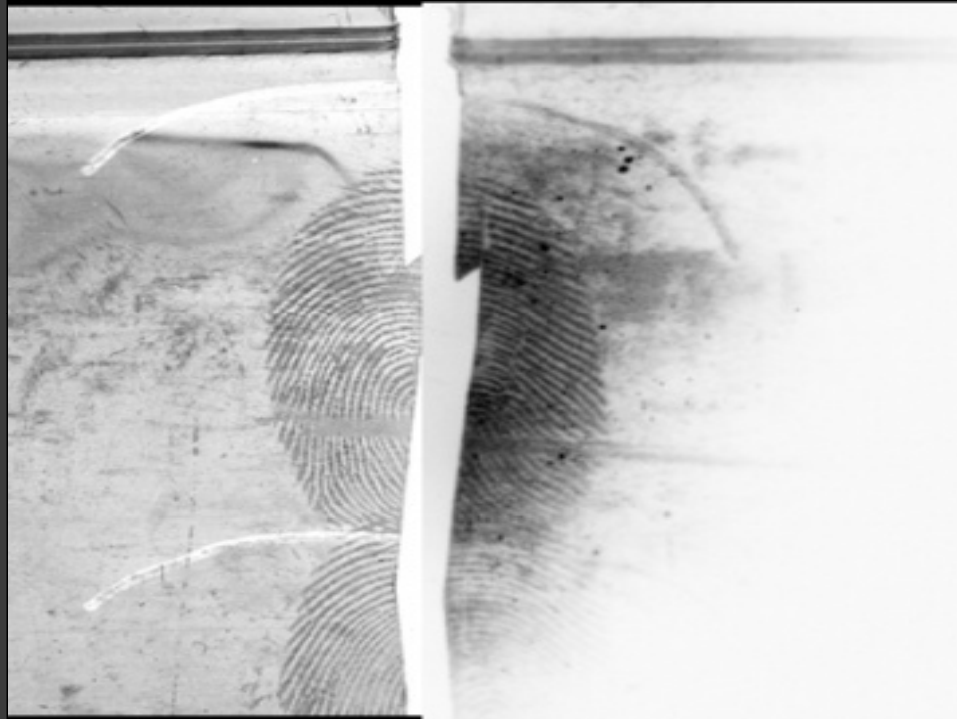


upconversion powder

Print #8 of a two week old eccrine depletion series developed on a black pebbled substrate.

Non-magnetic vs. Upconversion

Black carbon
powder



Upconversion
powder

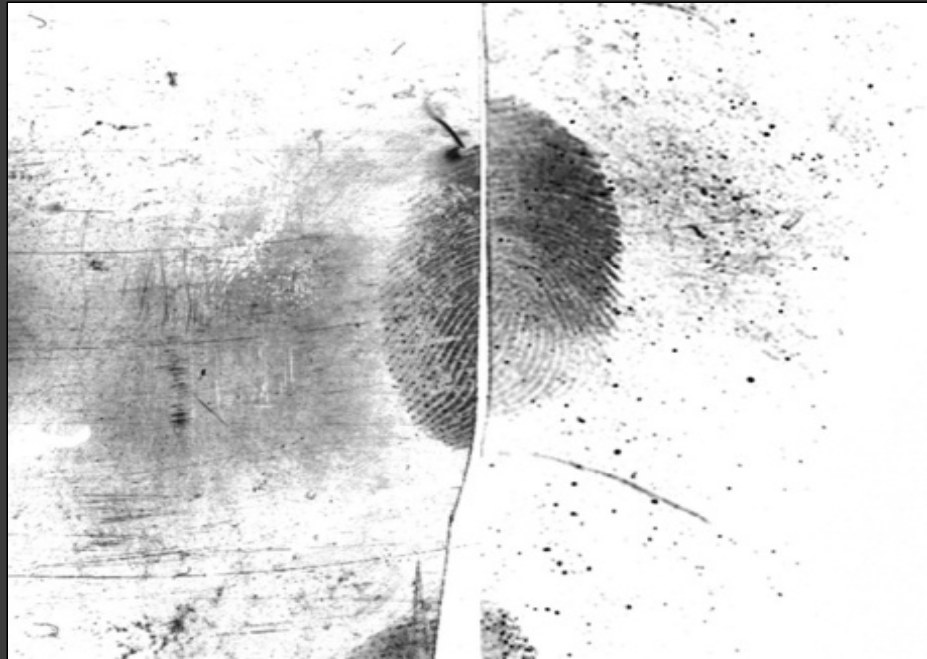
Print #1 of a two week old eccrine depletion series developed on an evidence bag

Non-magnetic vs. Upconversion

	Substrates	Black/white powder	Upconversion
	Trash bag	X	
	Evidence bag	X	
2 week old	Ziploc bag	X	
	Polypropylene sheet protector	X	
	Fold top bag	X	
	Black pebbled	X	
3 week old	White pebbled	X	
4 week old	Birthday bag	X	

Magnetic vs. Upconversion

Magnetic
powder

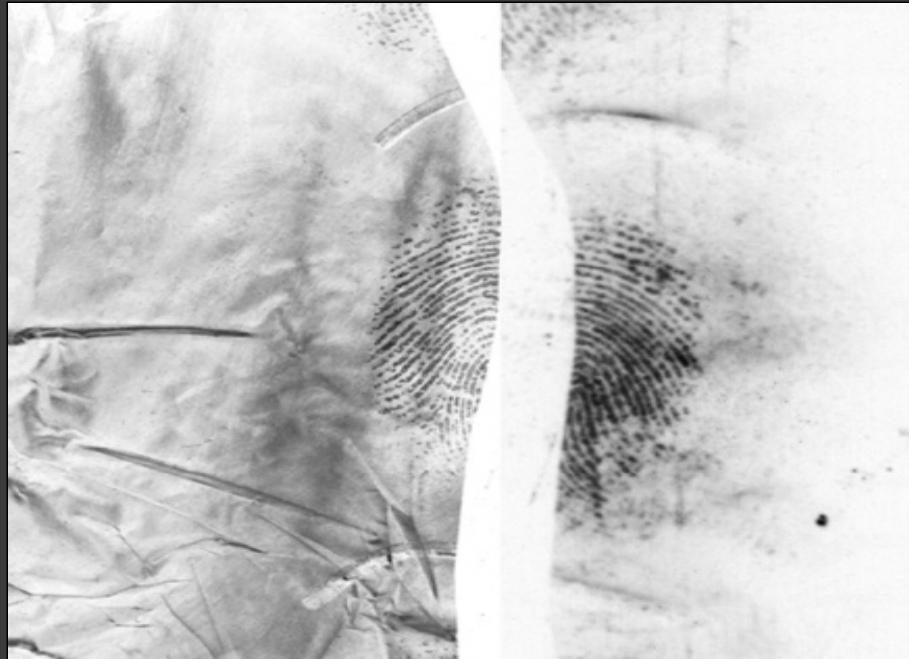


Upconversion
powder

Print #1 on a 1 ½ week old sebaceous depletion series developed on an evidence bag

Magnetic vs. Upconversion

White magnetic
powder



Upconversion
powder

**Halved print #2 of a two week old sebaceous
depletion series developed on a trash bag**

Magnetic vs. Upconversion

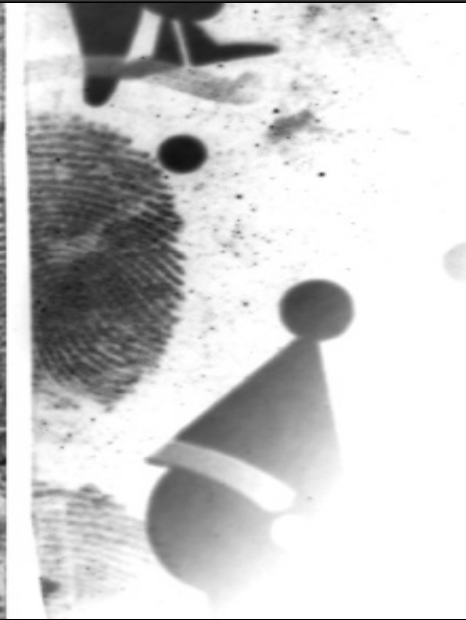
	Substrates	Magnetic	Upconversion
	Polypropylene sheet protector	X	
1.5 week old	Evidence bag	X	
	Coke can	X	
Separator			
	Ziploc bag	X	
	Evidence bag	X	
2 week old	Fold top bag	X	
	Polypropylene sheet protector	X	
	Black pebbled	X	
	Trash bag	X	
	PVC sheet protector	X	
Separator			
4 week old	Ziploc bag	X	

Greenwop vs. Upconversion

Greenwop



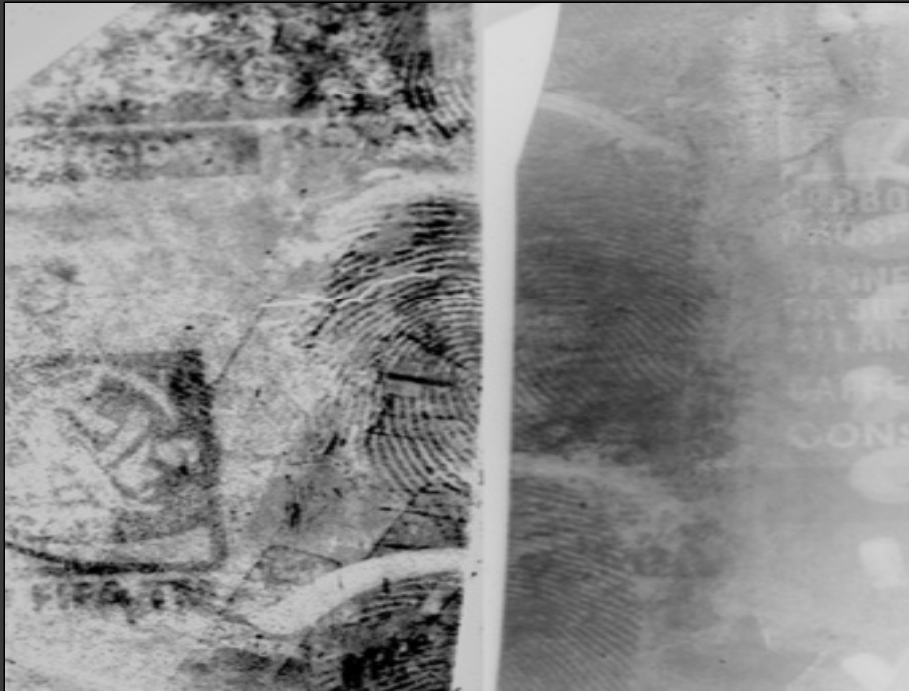
Upconversion



Print #6 of a 1 ½ week old sebaceous depletion series developed on a multicolored birthday bag

Greenwop vs. Upconversion

G
r
e
e
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w
o
p



**Print #2 of a two week old
eccrine depletion series
developed on a red Coke can**

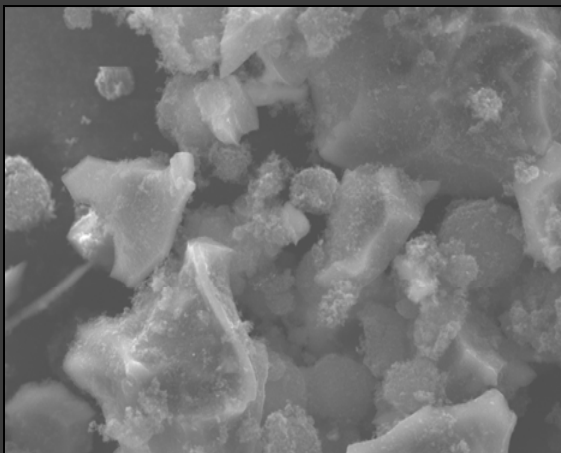


**The same Coke can
from the two week
old eccrine depletion
series. This is print
#3 from the
upconversion side**

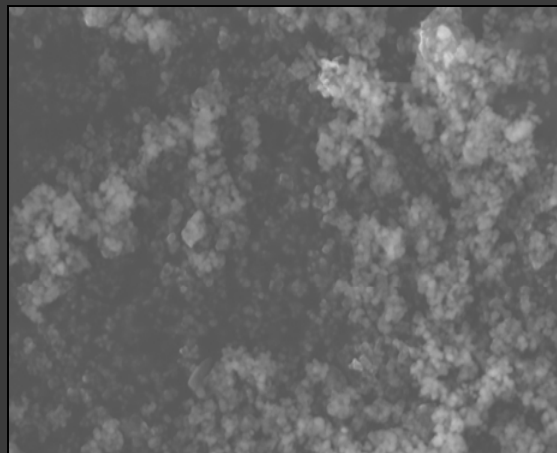
	Substrates	Greenwop	Upconversion
	Polypropylene sheet protector	X	
	Coke can	X	
1.5 week old	Bubble wrap	X	
	Trash bag	X	
	Birthday bag	X	
Separator			
	Evidence bag	X	
	Bubble wrap	X	
2 week old	Coke can	X	
	Birthday bag	X	
	Trash bag		X
Separator			
	Ziploc bag	X	
	PP sheet protector	X	
	PVC sheet protector	X	
3 week old	Evidence bag	X	
	Trash bag	X	
	Black pebbled	X	
	Birthday bag	X	
	Fold top bag	X	
Separator			
4 week old	Coke can	X	
	Birthday bag	X	

SEM Images

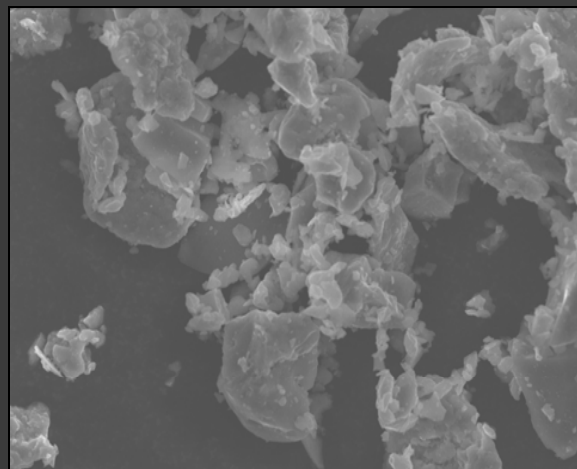
Black
Carbon



White

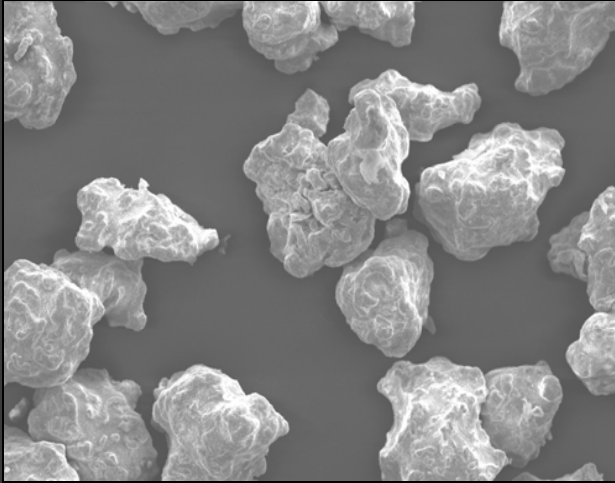


Black
magnetic

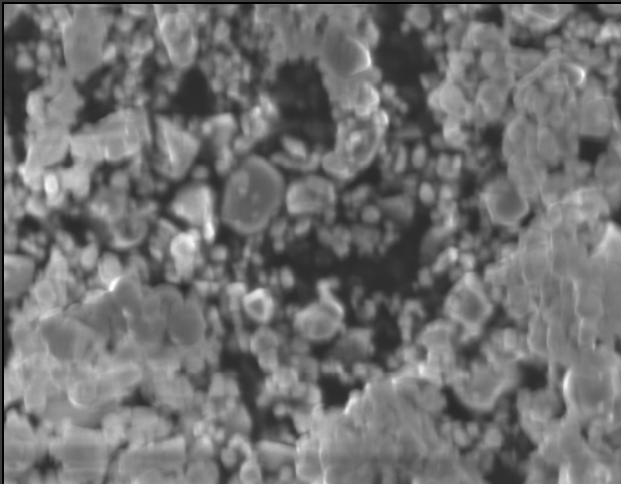
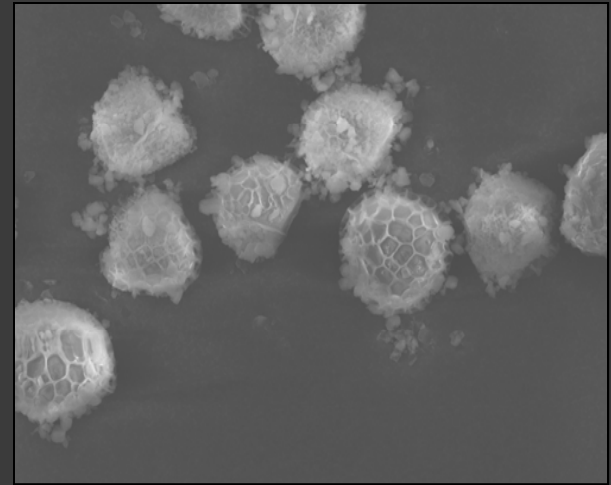


SEM Images

White
magnetic



Greenwop



Upconversion

Particle Sizes

Fingerprint Powder	Average Size of the Particles (µm)
Black Carbon	20-33
White	0.55-0.85
Black Magnetic	11-18
White Magnetic	100-160
Greenwop	1- 2.5
Upconversion	30-35

Conclusion

- ① The upconversion powder was not a better method of development than the conventionally used powders on the substrates
- ① The upconversion powder may have developed the prints well, but this was not translated through the camera

Further Study

- ⦿ Upconversion does have the potential
- ⦿ Run EDS scan of the powder to determine its elemental composition
- ⦿ Work with the laser and camera to better focus the upconversion images
- ⦿ Study the powder and laser with more strongly luminescent backgrounds



Questions??



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