**DEFENSE INTELLIGENCE AGENCY**

WASHINGTON, D.C. 20340-5100

FOIA-00120-2022
July 24, 2024

U-24-4513/IMO-2 (FOIA)

Mr. John Greenewald Jr.
The Black Vault, Inc.
Freelance Television Producer
27305 W. Live Oak Rd. Suite #1203
Castaic, CA 91384-4520

Dear Mr. Greenewald,

This responds to your Freedom of Information Act (FOIA) request, dated March 23, 2022, that you submitted to the Defense Intelligence Agency (DIA) for information concerning: ***A copy of the document TECHNOLOGY FORECAST: METAMATERIALS IN CLOAKING APPLICATIONS, published 14 June 2014***. I apologize for the delay in responding to your request as DIA continues its efforts to eliminate the large backlog of pending requests.

A search of DIA's systems of records located one document (6 pages) responsive to your request.

Upon review, while considering the foreseeable harm standard, I have determined that some portions of the document must be withheld in part from disclosure pursuant to the FOIA. The withheld portions are exempt from release pursuant to Exemptions 1, 3, and 6 of the FOIA, 5 U.S.C. § 552 (b)(1), (b)(3), and (b)(6). Exemption 1 applies to information properly classified under the criteria of Executive Order 13526. Exemption 3 applies to information specifically exempted by a statute establishing particular criteria for withholding. The applicable statutes are 10 U.S.C. § 424 and 50 U.S.C. § 3024(i). Statute 10 U.S.C. § 424 protects the identity of DIA employees, the organizational structure of the agency, and any function of DIA. Statute 50 U.S.C. § 3024(i) protects intelligence sources and methods. Exemption 6 applies to information which if released would constitute an unwarranted invasion of the personal privacy of other individuals. DIA has not withheld any reasonably segregable non-exempt portions of the records.

If you have additional questions/concerns you may:

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| Contact the FOIA Public Liaison | Email: FOIA1@dodiis.mil Phone: 301-394-6253 |
| File an administrative appeal (must be submitted within 90 days of the date on the letter) please contact us via one of the following and use FOIA-00120-2022 when referencing your case) | Email: FOIA1@dodiis.mil<br>Mail: Defense Intelligence Agency<br>ATTN: IMO-2C (FOIA)<br>7400 Pentagon<br>Washington, DC 20301-7400 |

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| For mediation services, you may contact the Office of Government Information Services (OGIS) at the National Archives and Records Administration to inquire | Email: ogis@nara.gov Phone: 202-741-5770<br>Toll-Free 1-877-684-6448 Facsimile: 202-741-5769<br>Mail: Office of Government Information Services<br>National Archives and Records Administration<br>8601 Adelphi Road-OGIS<br>College Park, MD 20740-6001 |

Sincerely,

(for)
Cheryl Cross-Davison
Chief, Records and Open Government

# Defense Intelligence Report

*TECHNOLOGY FORECAST*

9 June 2010

ICOD: 30 March 2010

DIA-08-1006-003

## (U) CHINA: Metamaterials In Cloaking Applications

(S/ (b)(3):10 USC 424

(b)(1); Sec. 1.4(c)

### (U) Source Summary Statement

(C/ (b)(3):10 USC 424

(b)(1); Sec. 1.4(c)

### (U) CLOAKING

(U) At META'10 [1] held in Cairo, Egypt on February 22-25, 2010, Professor C T Chan from The Hong Kong University of Science and Technology presented a brief on using metamaterials to create illusions. He disclosed his theoretical work, a key factor to design or select metamaterials.

- (U) Metamaterials can be designed to achieve "invisibility cloaks" which do not need to surround the object being cloaked [2].
- (U) Metamaterials can be used to create illusions (figure 1).
- (U) Active sources can be used to conceal an object and to create

~~Derived from: Multiple Sources~~

~~Declassify on: 30 March 2035~~

illusion effects at the same time (figure 2).

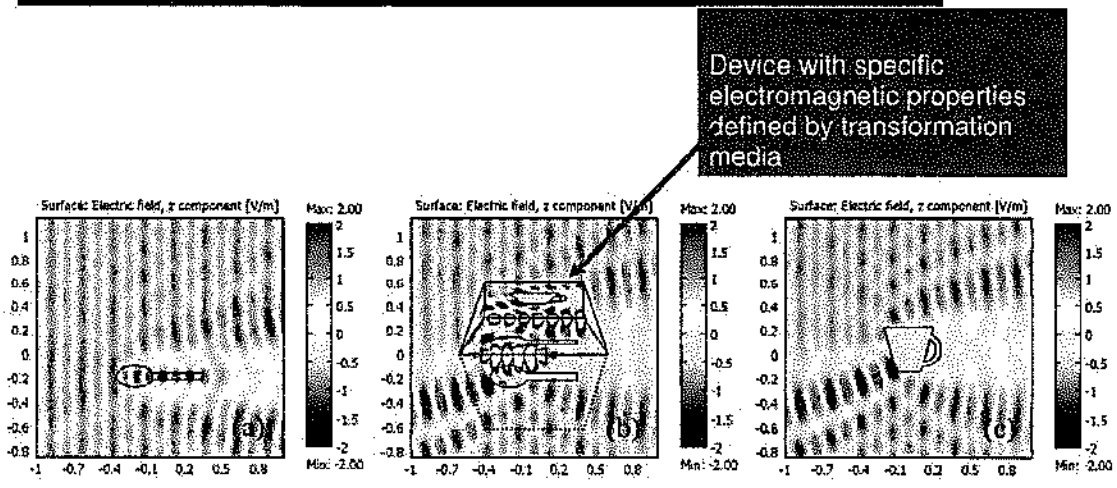


**Figure 2:** (U) Illusion from cloaking metamaterial: Changing a spoon into a cup.

(U) By using a mathematical technique known as Transformation Optics (transformation of the equations of wave propagation due to a transformation of the coordinate system) to design metamaterials to create illusions; Dr. Chan demonstrated how to make things invisible and make an apple look like a banana. In Dr Chan's opinion, an invisibility cloak is a special case of an illusion where an object is "optically transformed" by a device into "free space", and thereby becomes invisible. Transformation optics had previously been used for the theoretical design of cloaking structures that do not rely on the resonant response of elements of the cloaking structure to a single frequency radiation so that they can be used over a substantial frequency range.[3].

(U) Dr. Chan mentioned that his colleague at the Chinese Academy of Sciences, Institute of Electronics, Professor Chao Li has a group that has experimentally demonstrated the proof-of-concept of his theoretical work by using a transmission-line simulator (printed metallic strips over a ground plane, loaded with series capacitors and shunt inductor). It operates at 51 MHz over 10% bandwidth. The results will be published soon.

(U) He noted a limitation of remote cloaks and illusions. So far all the work has been passive: the transformation optics "remote devices" are passive (no power required), need negative refractive index (rely on material resonant response (metamaterials)), cannot easily cover a broad band and the cloak requires "anti-object". However, with an active source that generates waves to protect or cloak an object from other waves, Dr. Chan was able to show mathematically it is possible to hide a collection of extended objects of arbitrary shape at finite frequencies outside the cloak.

~~(S//~~ (b)(3):10 USC 424

(b)(1); Sec. 1.4(c)

(U) There has been tremendous progress in metamaterials since work at Duke University in the United States in 2006, where researchers demonstrated a cloak at a microwave frequency[5]. Until 2009, experiments were limited to certain wavelengths such as microwaves and infrared light, and every method tried so far has limitations.

- (U) In January 2009, the Duke University researcher who built the first invisibility cloak in 2006 created software that speeds up the design of metamaterials[6]. He and his colleagues have used the program to build a complex light cloak that's invisible to a broad band of microwave light--and they did it in only 10 days.
- (U) In May 2009 researchers from UC Berkeley[7] created a "carpet cloak" from nanostructured silicon that conceals the presence of objects placed under it from optical detection.
- (U) In July 2009 researchers from Universitat Autonoma de Barcelona (UAB, Spain)[8] designed a device which makes objects invisible under certain light (very low frequency electromagnetic waves) by making the interior magnetic field zero but not altering the exterior field. The device, which up to now has only been studied theoretically, acts as an invisibility cloak, making the object completely undetectable to these waves.

- (U) In August 2009, researchers from the University of Utah[9] showed that it is numerically possible to cloak objects of any shape that lie outside the cloaking devices, not just from single-frequency waves, but from pulses generated by a multi-frequency source.

## (U) TONE BOXES

### (U) Metamaterials

(U) A metamaterial is a man-made material usually having periodic structures. Metamaterials can be designed to cause electromagnetic waves (such as light or radio waves) whose wavelength is much larger than the unit structure of the metamaterial to propagate in ways that are not attainable using natural materials.

## (U) FUNDING

~~(S//~~ (b)(3):10 USC 424

(b)(1); Sec. 1.4(c)

## (U) OUTLOOK, IMPLICATIONS, AND OPPORTUNITIES

~~(S//~~ (b)(3):10 USC 424

(b)(1); Sec. 1.4(c)

- (U) How do atmospheric conditions between the object and the cloak effect cloaking at optical frequencies?

(b)(3):10 USC 424; (b)(3):50 USC 3024(i); (b)(6)

[1] (U) Website; http://meta10.lgep.supelec.fr/index.php/meta/META10, February 2010. Overall classification is U
[2] (U) Journal; Y Lai et al., 2009, Phys.Rev.Lett. 102, 093901, Complementary media invisibility cloak that cloaks objects at a distance outside the cloaking shell. Overall classification is U
[3] (U) DIA DIR; (b)(3):10 USC 424
Transformation Optics Aiding Development of Low-Radar-Cross-Section Technologies Based on Metamaterials (U), Overall classification is ~~TS~~ ~~NF~~ (b)(3):50 USC 3024(i)
[4] (U) Journal; Leonhardt and Tyc, 2009, Science 323. 110, Broadband invisibility by non-Euclidean cloaking. Overall classification is U
[5] (U) Journal; D Schurig et al., 2006, M Science 314, 977, Metamaterial electromagnetic cloak at microwave frequency. Overall classification is U
[6] (U) Website; http://www.technologyreview.com/computing/21971/?a=f, January 2009. Overall classification is U

[7] (U) Website; http://www.sciencedaily.com/releases/2009/05/090501154143.htm, May 2009. Overall classification is U

[8] (U) Website; http://www.sciencedaily.com/releases/2009/07/090707094822.htm, July 2009. Overall classification is U

[9] (U) Website; http://www.sciencedaily.com/releases/2009/08/090817073508.htm, August 2009. Overall classification is U

[10] ~~(S//NF)~~ (b)(3):10 USC 424 (b)(1); Sec. 1.4(c)
Overall classification is ~~S//NF~~

[11] ~~(S//NF)~~ (b)(3):10 USC 424 (b)(1); Sec. 1.4(c)
Overall classification is ~~S//NF~~