TERAHERTZ SPECTROSCOPY AND IMAGING

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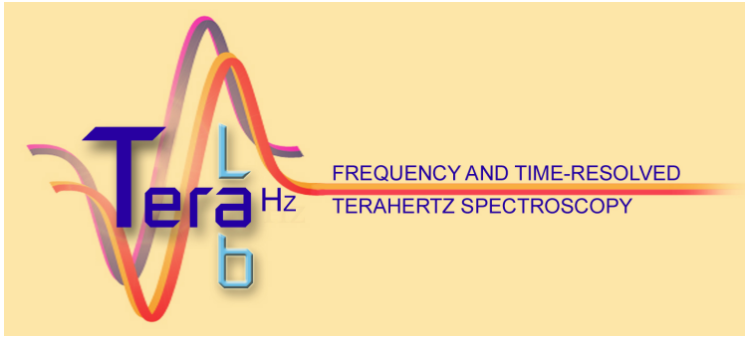
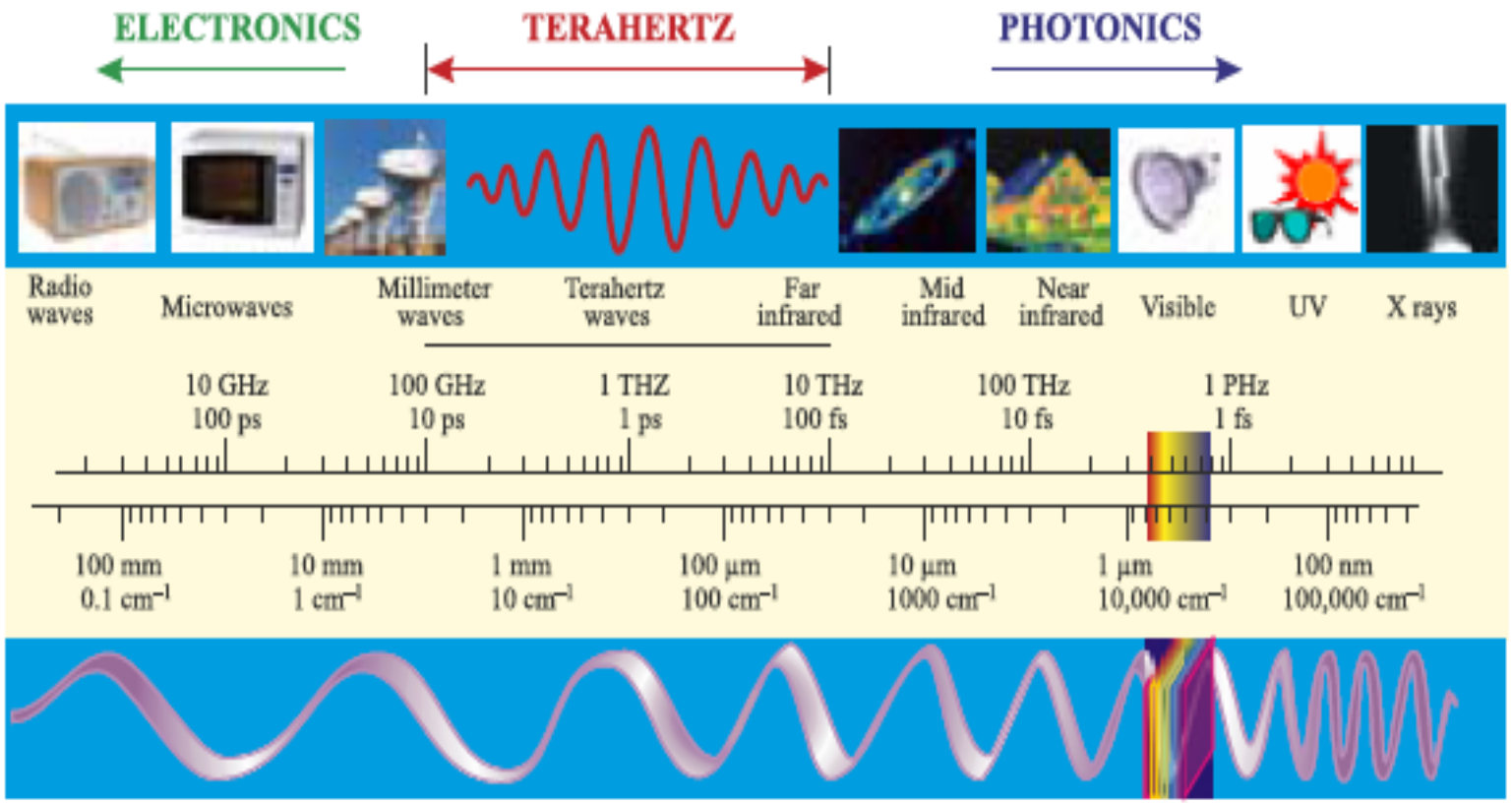
Sapienza University of Rome, Italy



SAPIENZA
UNIVERSITÀ DI ROMA

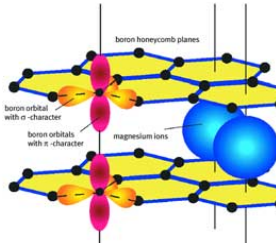
Regione Spettrale Terahertz



Spectroscopic Units: 200 cm^{-1}=300 K= 25 meV = 50 μm = 7 THz

Applicazioni THz

Fisica dei Materiali

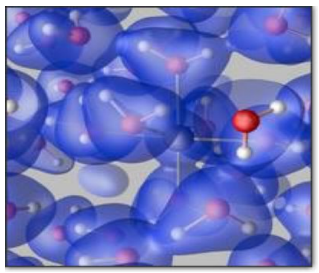


Grafene e Metariali 2D
Elettrodinamica e trasporto
Detectors

Superconduttività
Gap energetica
Simmetria del parametro d'ordine
Determinazione del peso del condensatoamics Dinamica veloce delle coppie di Cooper

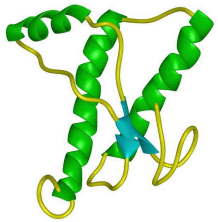
Transizioni di fase
Controllo del magnetismo
Controllo delle transizioni struttural

Chimica dei Materiali



Soluzioni
Legame Idrogeno
Interazioni Van der Waals
Dinamica veloce e controllo e attivazione delle reazioni chimiche
Batterie Li

Scienze della vita

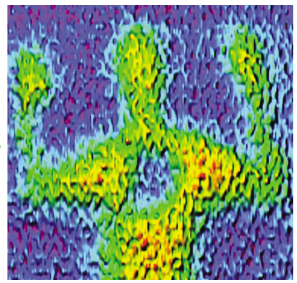


Macromolecole
Studio e controllo della conformazione Macromolecolare
Dinamica veloce delle macromolecole

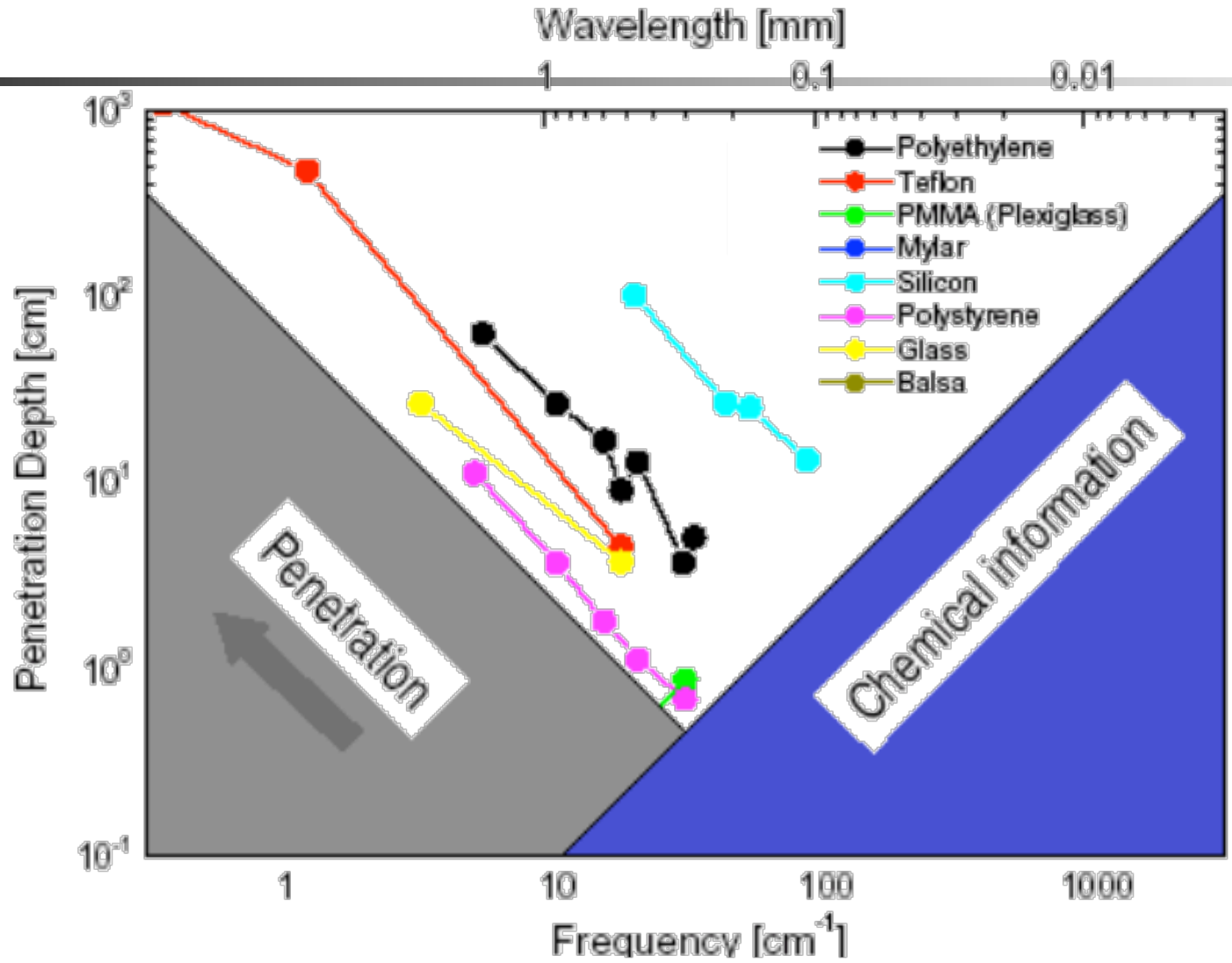
Imaging
Tomografia 3Dimensionale di tessuti
Diagnostica tumorale
Microscopia al di la del limite di diffrazione

Nuove Tecnologie e Applicazioni industriali

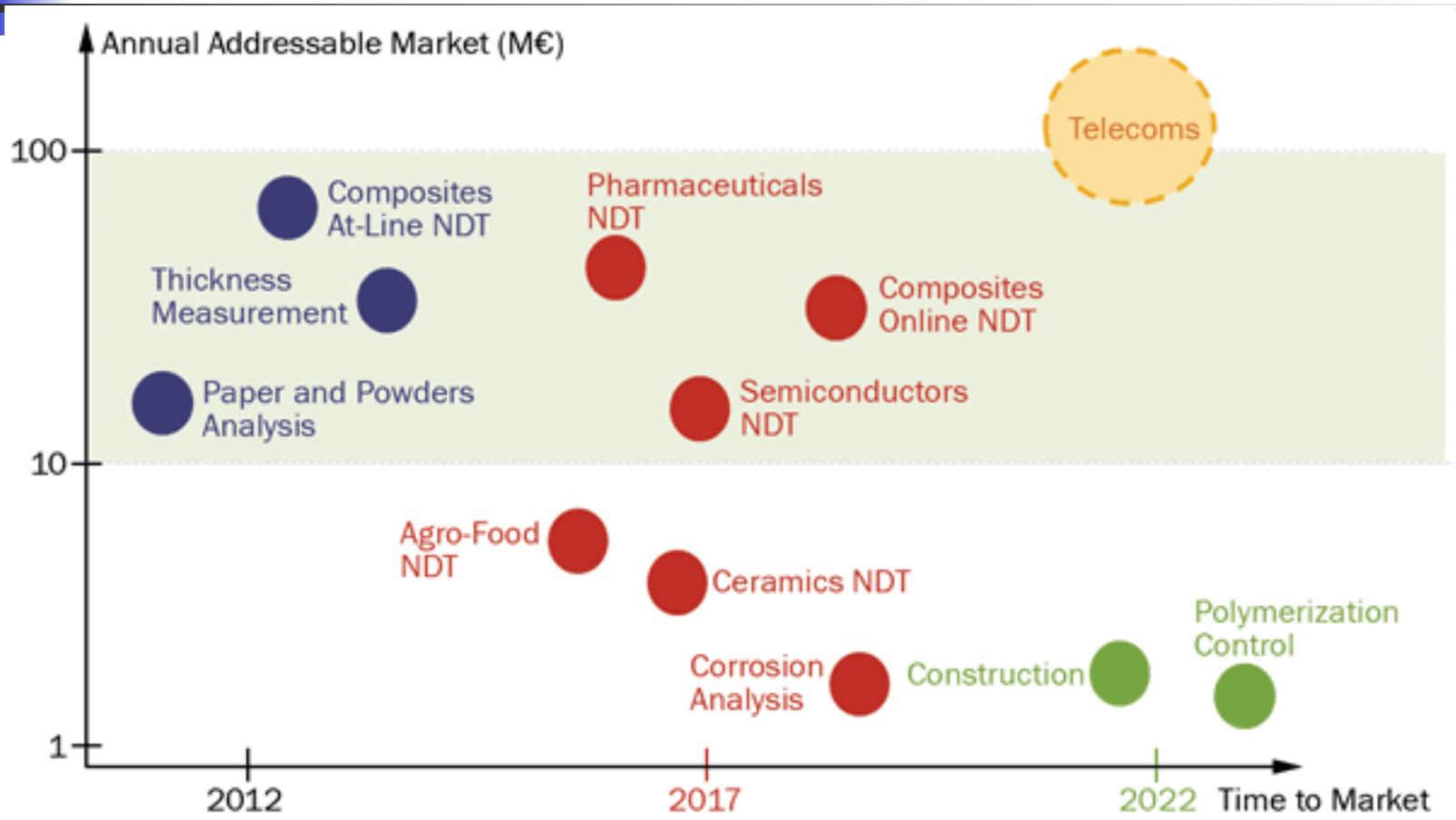
Tecnologie THz-IR
Detectors
Materiali innovativi ottici
Imaging THz e IR
Accelerazione e Diagnostica di fasci di particelle
Controllo industriale
Controlli qualità
Sicurezza
Bio-hazard
Sicurezza alimentare



Riconoscimento chimico versus Penetrazione



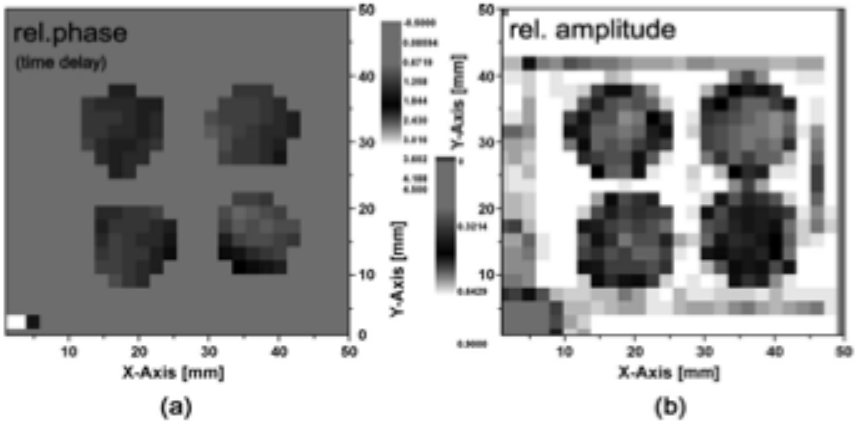
A Road Map of Terahertz Industrial Applications



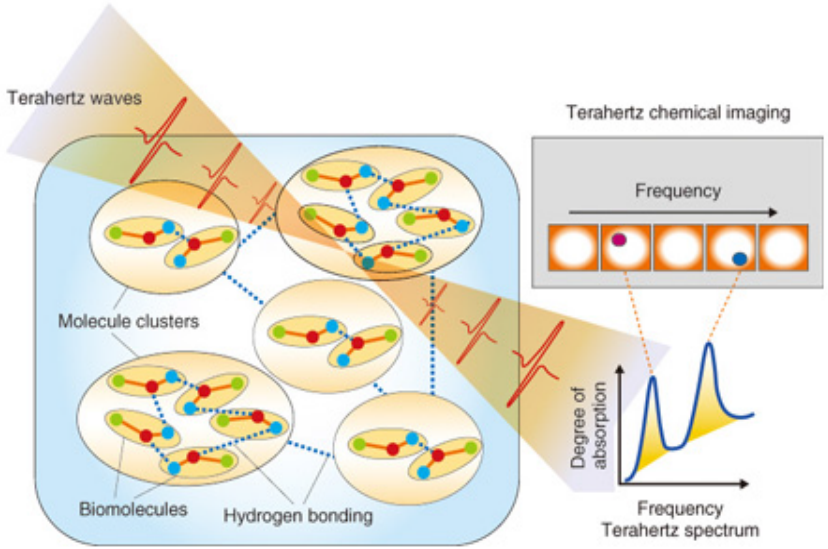
Nature Photonics 2014

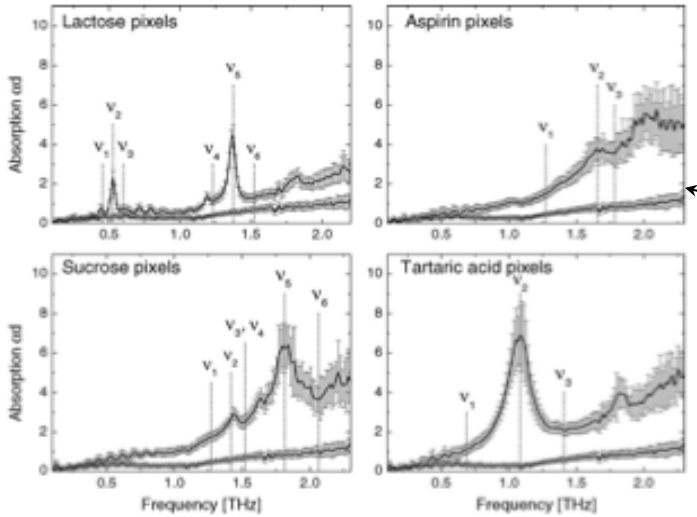
Applicazioni farmaceutiche

Fig. 8. *Visible image of sample with four pellets containing different chemicals: (1) lactose, (2) aspirin, (3) sucrose, and (4) tartaric acid.*



ransmittance image of the sample shown in Fig. 8.





Background absorption

Fig. 10. *Solid lines show the average absorption of lactose (top, left), aspirin (top, right), sucrose (down, left), and tartaric acid (down, right) in the sample. The lower curve in each panel shows the absorption of the packaging material. The error bars represent one standard deviation from the mean of typically 20–30 measurements. The indicated frequencies are used for chemical recognition. After [20].*

Biomedicina: Imaging di tessuti tumurali

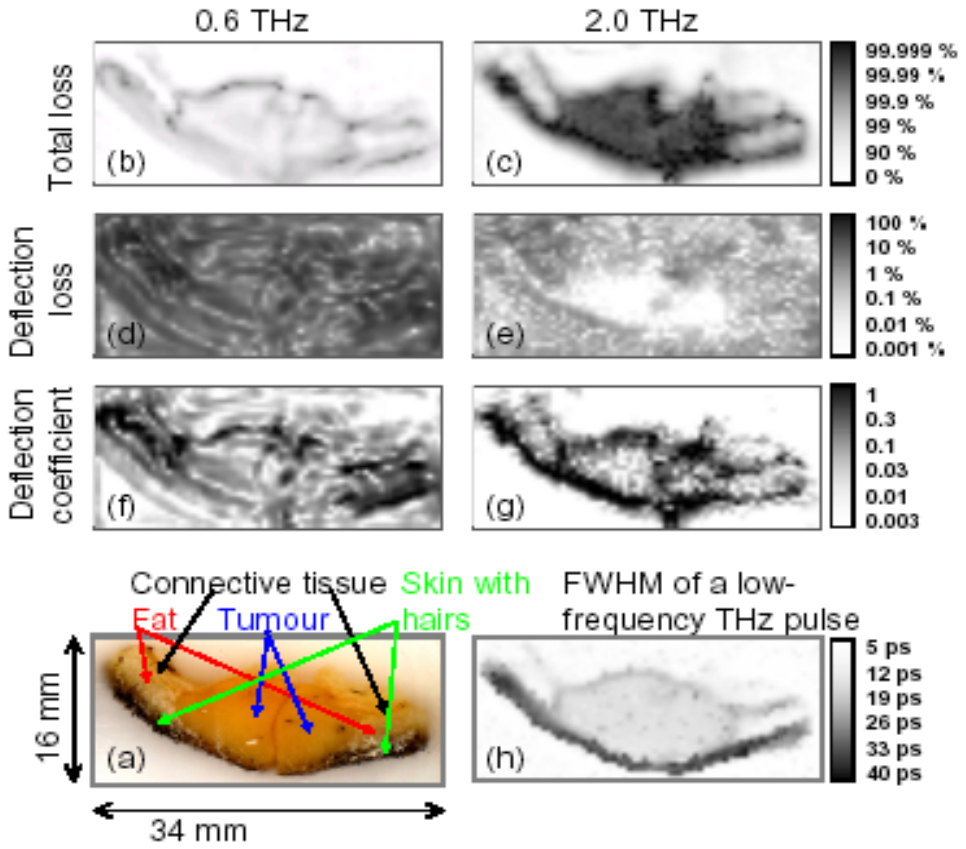
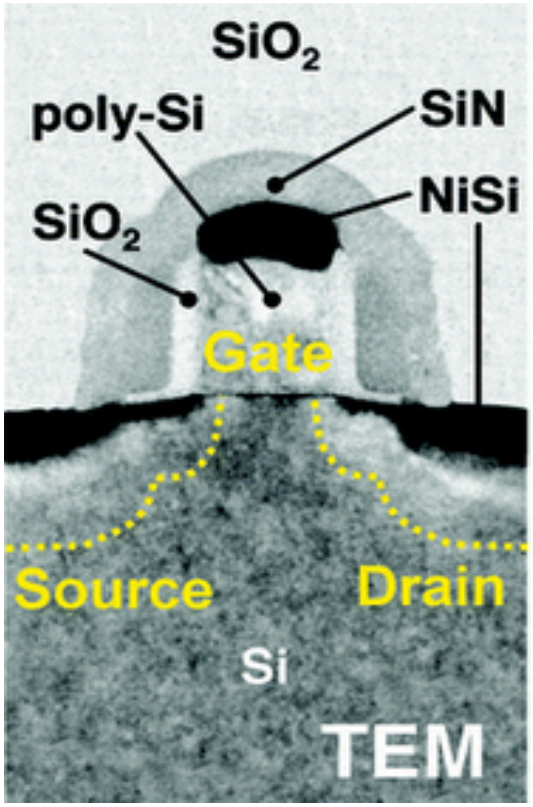
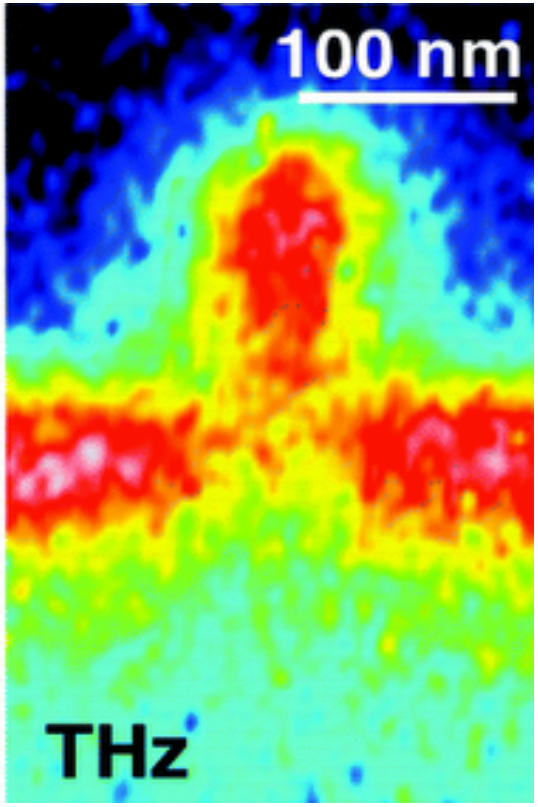


Fig. 3. (a) Optical image of the sample; (b) and (c): Total loss in transmission, (d) and (e): Loss induced by deflection; (f) and (g): Deflection coefficient. (h) Pulse duration (FWHM) of a low-frequency THz pulse. Click on Fig. 3(b,d,f) to see the data as a function of the frequency. (426 kB QuickTime movie)

Distribuzione elettroni in un FET





Plasmonica THz

ACS Photonics

Article

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Superconductivity-Induced Transparency in Terahertz Metamaterials

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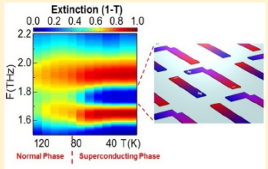
Supporting Information

ABSTRACT: A plasmonic analogue of electromagnetically induced transparency is activated and tuned in the terahertz (THz) range in asymmetric metamaterials fabricated from high critical temperature (T_c) superconductor thin films. The asymmetric design provides a near-field coupling between a superradiant and a subradiant plasmonic mode, which has been widely tuned through superconductivity and monitored by Fourier transform infrared spectroscopy. The sharp transparency window that appears in the extinction spectrum exhibits a relative modulation up to 50% activated by temperature change. The interplay between ohmic and radiative damping, which can be independently tuned and controlled, allows for engineering the electromagnetically induced transparency of the metamaterial far beyond the current state-of-the-art, which relies on standard metals or low-T_c superconductors.



nature nanotechnology

LETTERS

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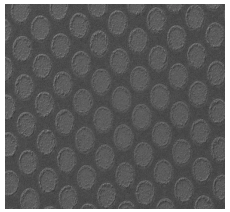
Observation of Dirac plasmons in a topological insulator

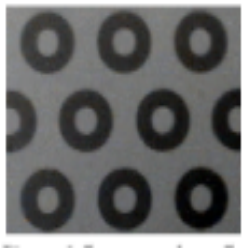
P. Di Pietro[1,2], M. Ortolani[2,3], O. Limaj[2,4], A. Di Gaspare[3], V. Giliberti[2,3], F. Giorgianni[2,4], M. Brahlek[5], N. Bansal[5], N. Koirala[5], S. Oh[5], P. Calvani[1,2] and S. Lupi[2,4,6]*

Ribbons

Disks



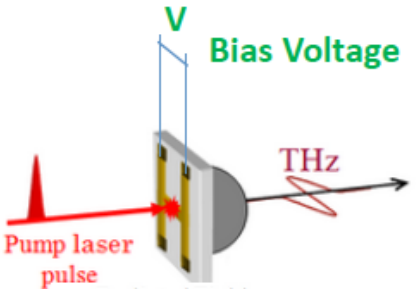
Rings



Avalaible Terahertz Sources among Sapienza and LNF

Laser based Sources:

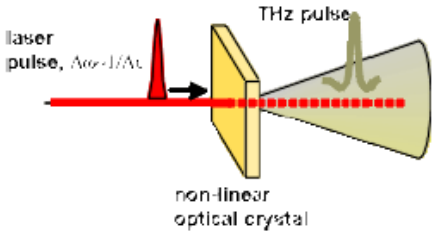
Photoconductive Antennas (PCA)



Radiated Field:

$$E_{THz}(t) \propto \frac{\partial J(t)}{\partial t}$$

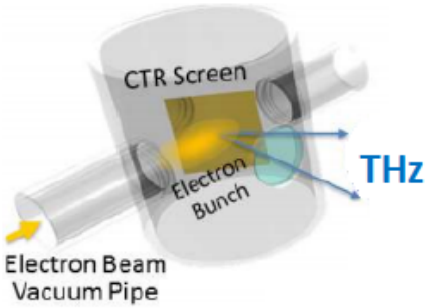
Non-linear Crystals (NLC)



Difference Frequency Mixing

Free electrons based Source

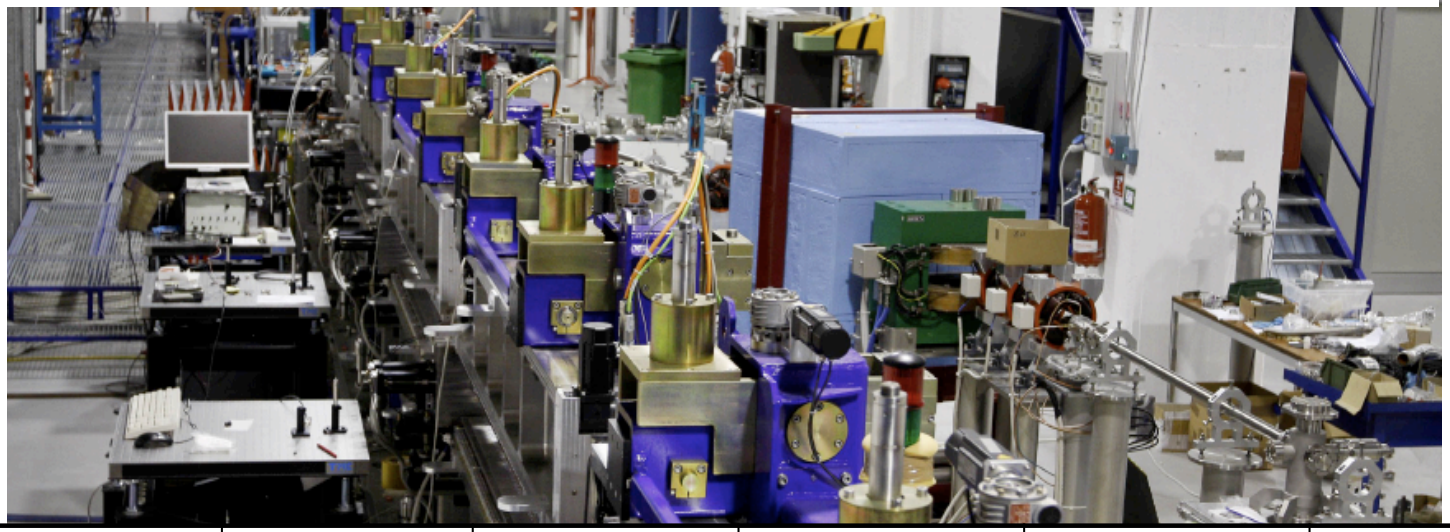
Coherent Transition Radiation (CTR)



	Average THz Power	THz Energy per Pulse	Repetition Rate	Pulse Duration	Spectral Range
PCA	1 uW	≈ pJ	80 MHz	≈ 1 ps	50 GHz-2 THz
NLC	1 uW	≈ pJ	80 MHz	≈ 100 fs	50 GHz-4 THz
CTR-SPARC	300 uW	> 30 uJ	10 Hz	≈ 100 fs	500 GHz-5 THz

SPARC THz Source

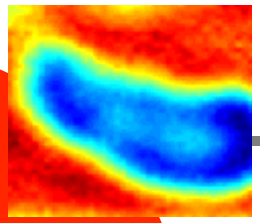
Free Electron Laser SPARC@LNF



	Electron beam energy	Charge	Δt (bandwidth)	THz pulse energy	E-field
THz@SPARC	120 MeV	500 pC	100 fs (3 THz)	≈30 μJ	MV/cm

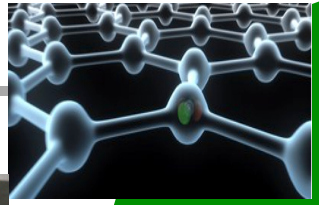
E. Chiadroni, et al, APL 2013

Terahertz on-going projects and Expertise



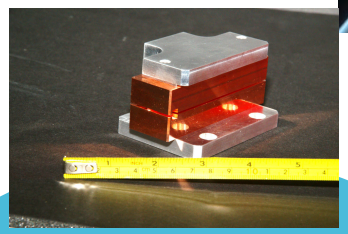
Imaging Biomedico

Imaging spettrale THz +NIR su tessuti cancerosi *in vivo*



Material Science

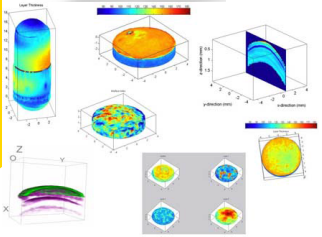
Studio di materiali innovativi: grafene etc, con spettroscopia THz risolta in frequenza e tempo



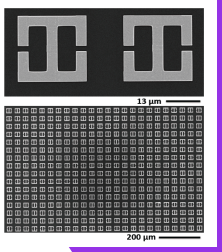
Studio ottico di cavità acceleranti THz

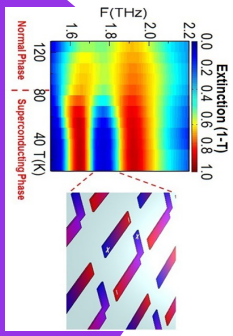
Microscopia THz in campo vicino e lontano

Proprietà strutturali dei materiali: Polimeri; Cementi, Legno; Schermaggio elettromagnetico THz e Sub-THz



Plasmonica e sensing su sistemi di interesse biologico





Acknowledgments

The TERALAB group:
F. Giorgianni
M. Daniele

FREQUENCY AND TIME-RESOLVED
TERAHERTZ SPECTROSCOPY

Thank for your attention

SPARC_LAB

The LNF-INFN SPARC Lab group:
E. Chiadroni and the SPARC THz collaboration