EXPERIMENTAL MEASUREMENTS OF PHOTO-ACOUSTIC SIGNAL IN A CLUSTER OF PT-C NANO-HELICES

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Esposito M.[2,3], Tasco V.[2], Passaseo A.[2]

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2 – «CNR Nanotec», Istituto di Nanotecnologia, Polo di Nanotecnologia, c/o Campus Ecotekne, via Monteroni I-73100 Lecce.
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SAPIENZA
UNIVERSITÀ DI ROMA

DIPARTIMENTO DI
SCIENZE DI BASE E APPLICATE PER L'INGEGNERIA

UNIVERSITÀ DEL SALENTO

NANOTEC
ISTITUTO DI NANOTECNOLOGIA

PAROLE-CHIAVE

1 – Chiralità (3D, 2D reale e 2D estrinseca)

2 – Polarizzazione circolare

3 – Effetto fotoacustico

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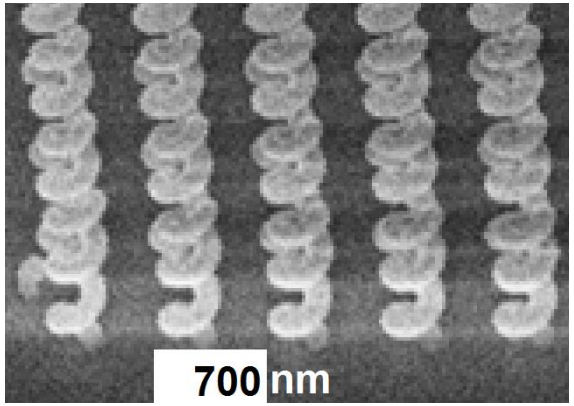

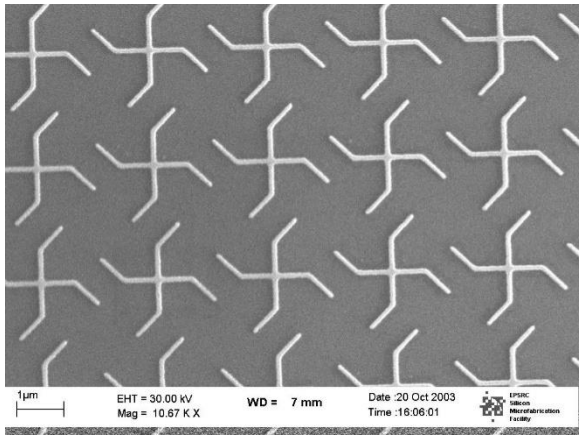

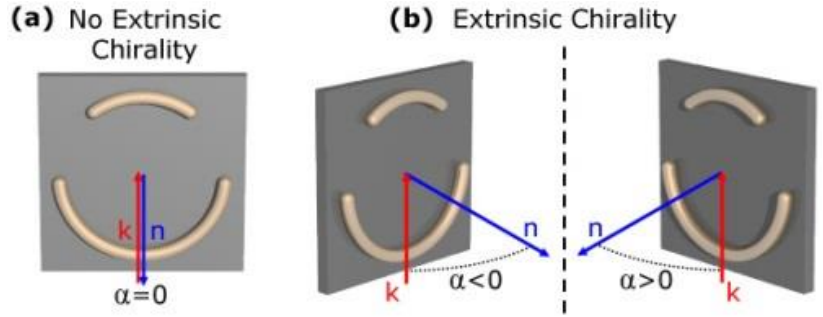

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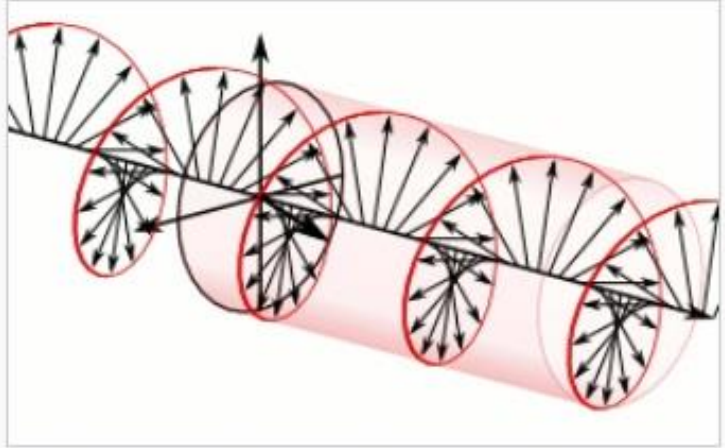
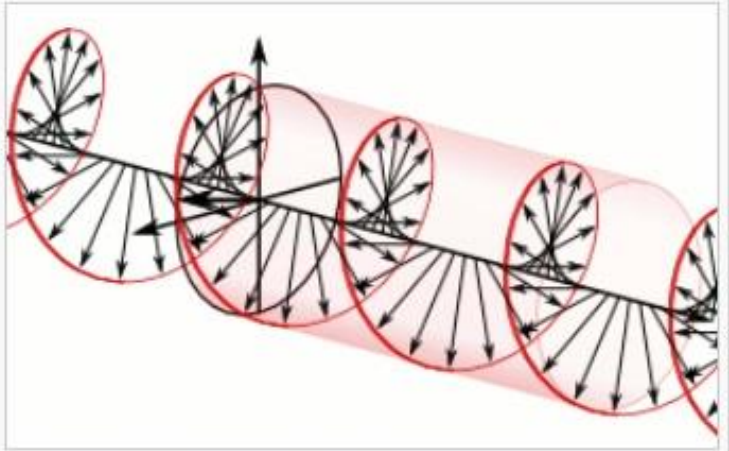


A right-handed/clockwise circularly polarized wave as defined from the point of view of the source. It would be considered left-handed/anti-clockwise circularly polarized if defined from the point of view of the receiver.



A left-handed/anti-clockwise circularly polarized wave as defined from the point of view of the source. It would be considered right-handed/clockwise circularly polarized if defined from the point of view of the receiver.

IEEE Std 149-1979 (R2008), "IEEE Standard Test Procedures for Antennas". Reaffirmed December 10, 2008, Approved December 15, 1977, IEEE-SA Standards Board. Approved October 9, 2003, American National Standards Institute.
ISBN 0-471-08032-2. doi:10.1109/IEEESTD.1979.120310, sec. 11.1, p. 61."the sense of polarization, or handedness ... is called right handed (left handed) if the direction of rotation is clockwise (anti-clockwise) for an observer looking in the direction of propagation"

PAROLE-CHIAVE

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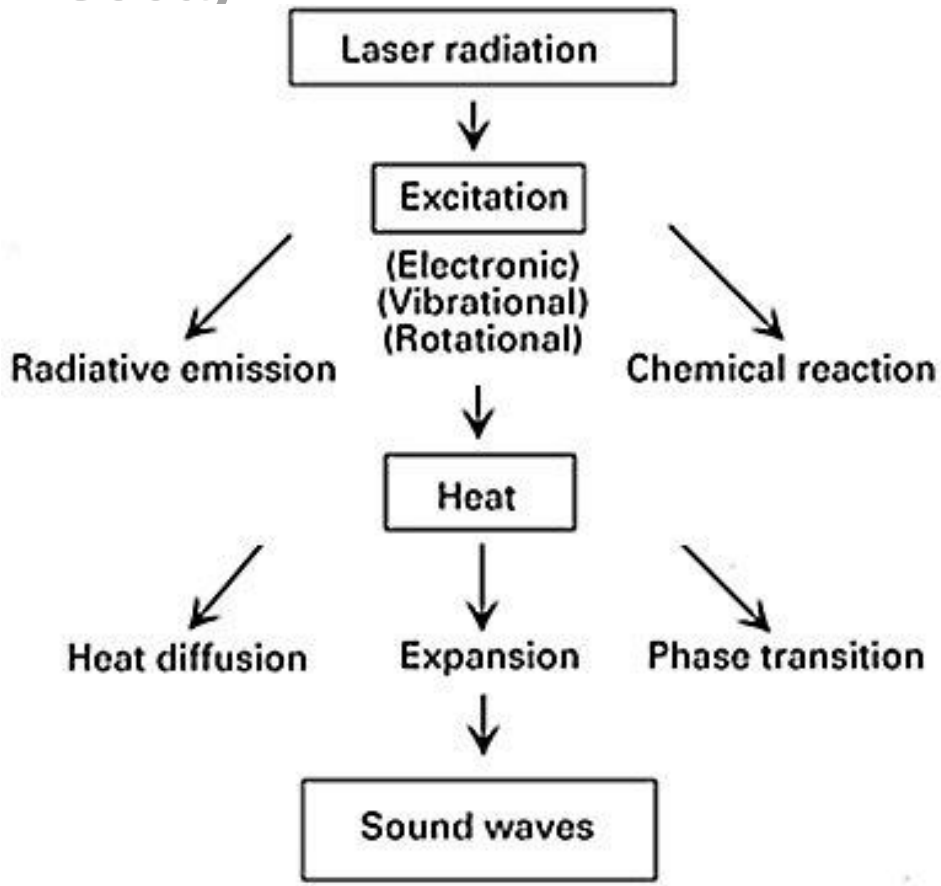

SINOSSI

1 – Progetto approssimativo della struttura e realizzazione delle varie classi di nano-strutture

2 – Misure tutto-ottiche e Fotoacustiche

3 – Analisi numerica
- 3.1 – Metodo di calcolo degli indici rifrattivi
- 3.2 – Simulazioni dei campioni

4 – Conclusioni

1 – Progetto approssimativo della struttura e realizzazione delle varie classi di nano-strutture

EXPERIMENTAL MEASUREMENTS OF PHOTO-ACOUSTIC SIGNAL IN A CLUSTER OF PT-C NANO-HELICES

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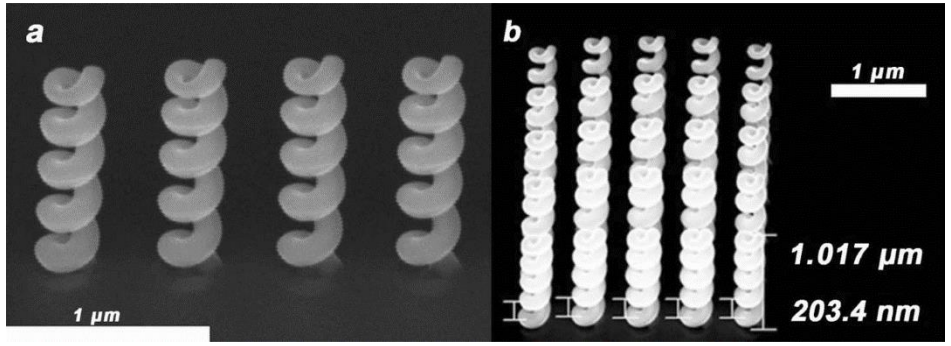
SOCIETÀ ITALIANA DI FISICA



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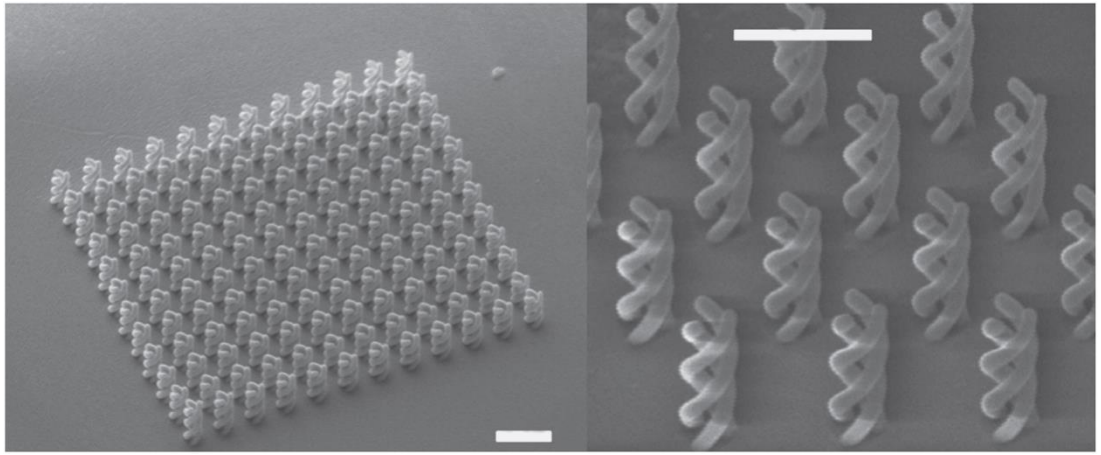

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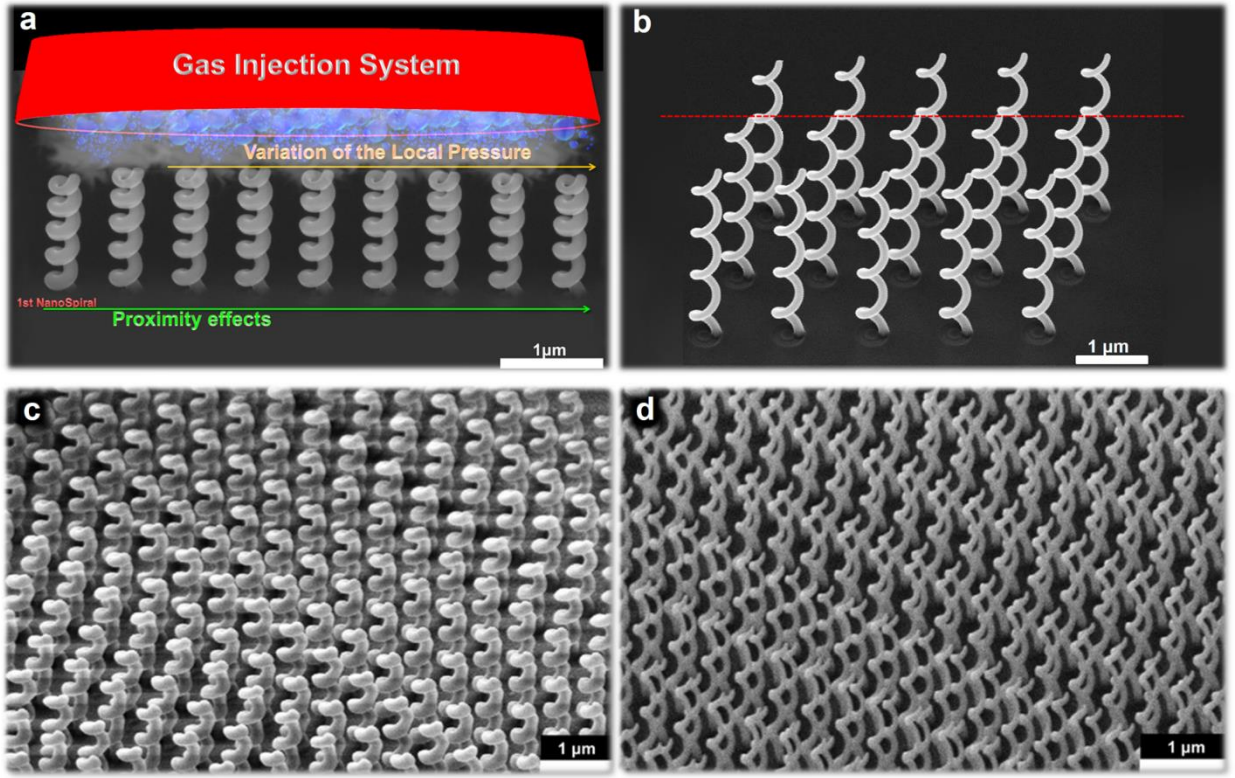

1 M. Esposito, V. Tasco, F. Todisco, A. Benedetti, D. Sanvitto, A. Passaseo, Advanced Optical Materials, Volume 2, Issue 2, Pages 154–161 (2014).
2 M. Esposito, V. Tasco, M. Cuscunà, F. Todisco, A. Benedetti, I. Tarantini, M. De Giorgi, D. Sanvitto, A. Passaseo, ACS Photonics, Volume 2, Number 1, Pages 105–114 (2014).
3 M. Esposito, V. Tasco, F. Todisco, M. Cuscunà, A. Benedetti, D. Sanvitto, A. Passaseo, Nature Communications, Volume 6, Article Number 6484 (2015).
4 Marco Esposito, Vittorianna Tasco, Francesco Todisco, Alessio Benedetti, Iolena Tarantini, Massimo Cuscunà, Lorenzo Dominici, Milena De Giorgi, Adriana Passaseo, “Tailoring chiro-optical effects by helical nanowire arrangement”, Nanoscale (in press, 2015)

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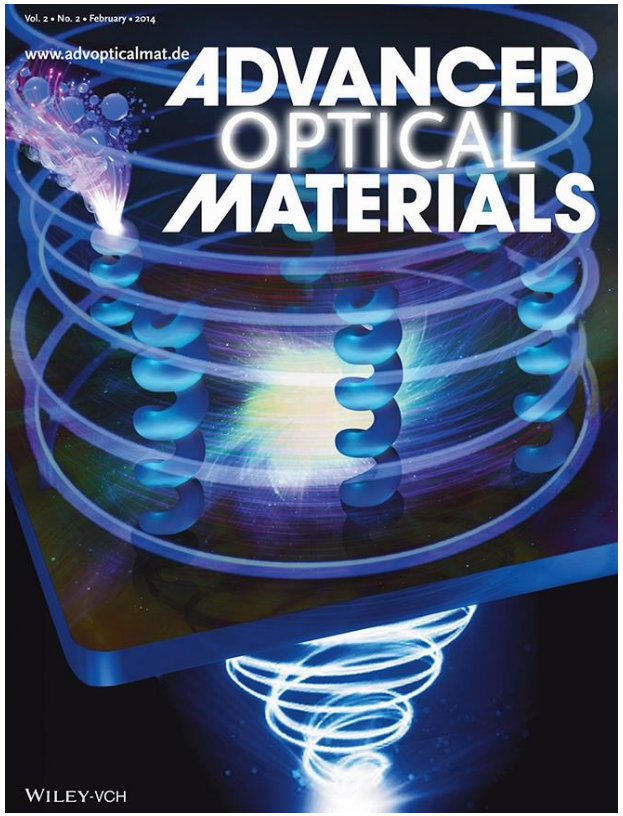

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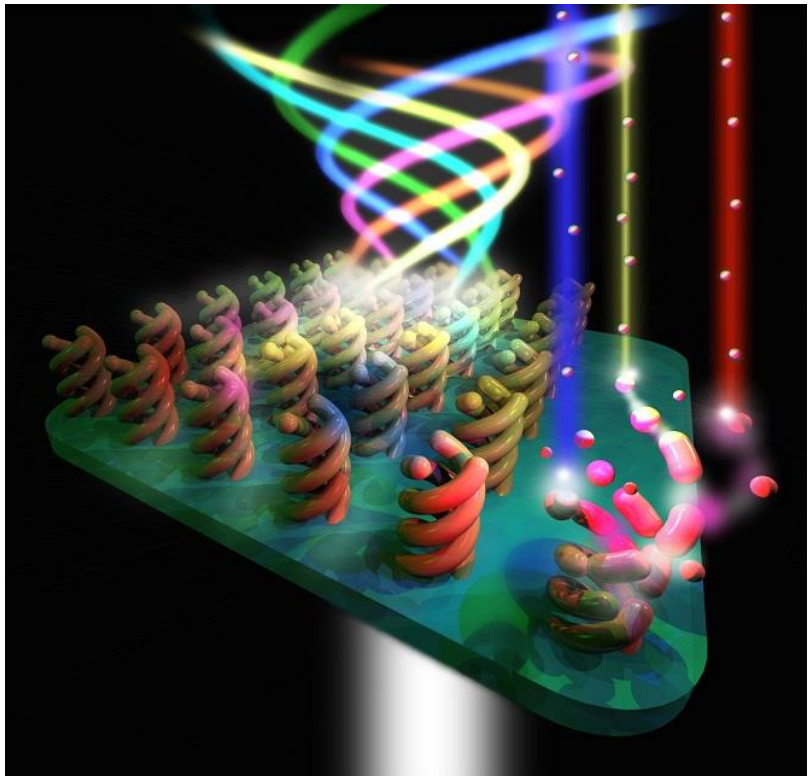

*3

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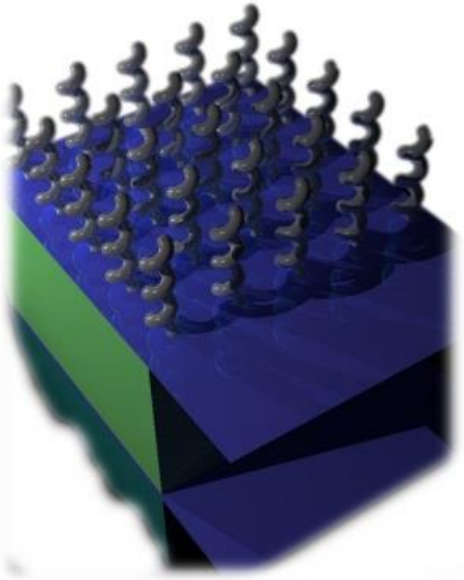
EXPERIMENTAL MEASUREMENTS OF PHOTO-ACOUSTIC SIGNAL IN A CLUSTER OF PT-C NANO-HELICES

Italian Physical Society
Società Italiana di Fisica

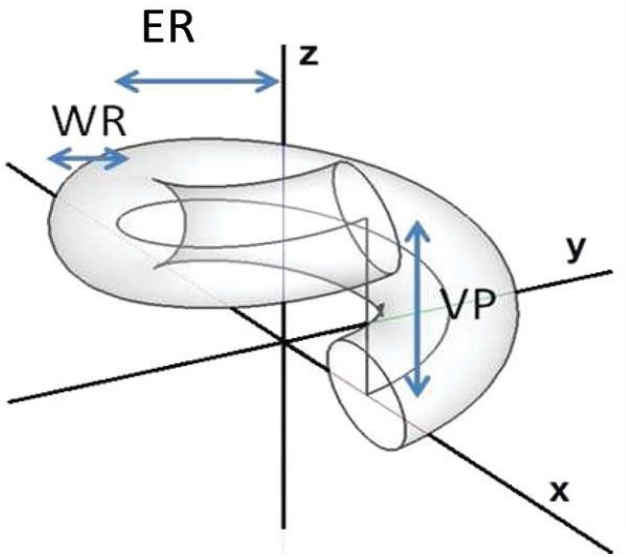
The substrate, composed of a conductive 20nm thick $Al_{0.3}Ga_{0.7}N$ layer, located in direct contact with the helices, followed by a 2µm thick GaN layer, then by a 100nm thick AlN. Finally, a thick (~mm) Al2O3 substrate is located at the bottom of the entire structure.

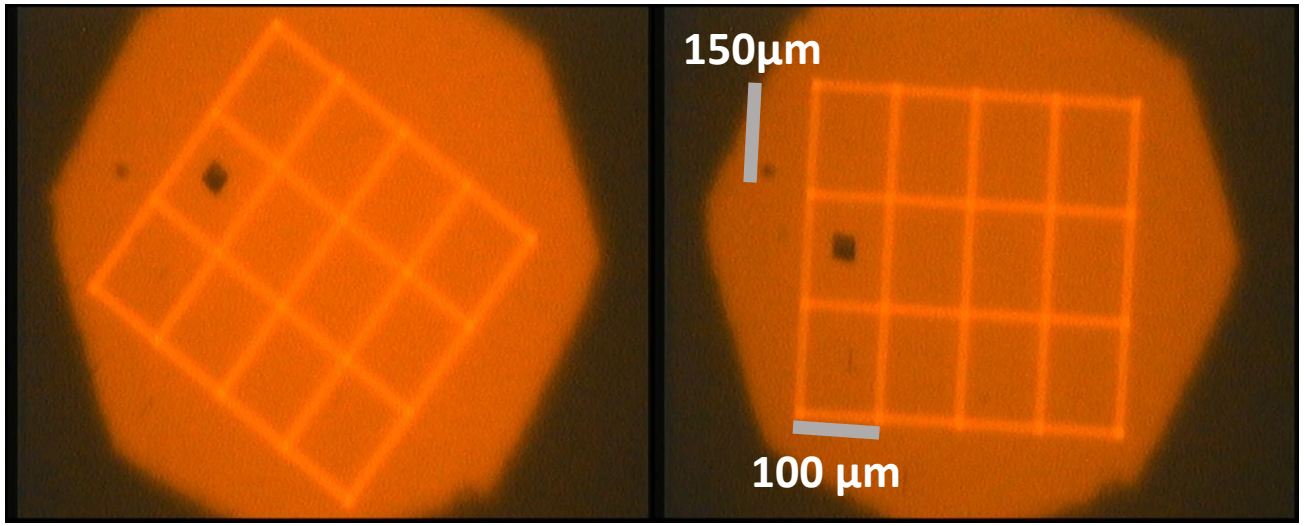
Helices form a 40x40 square array.

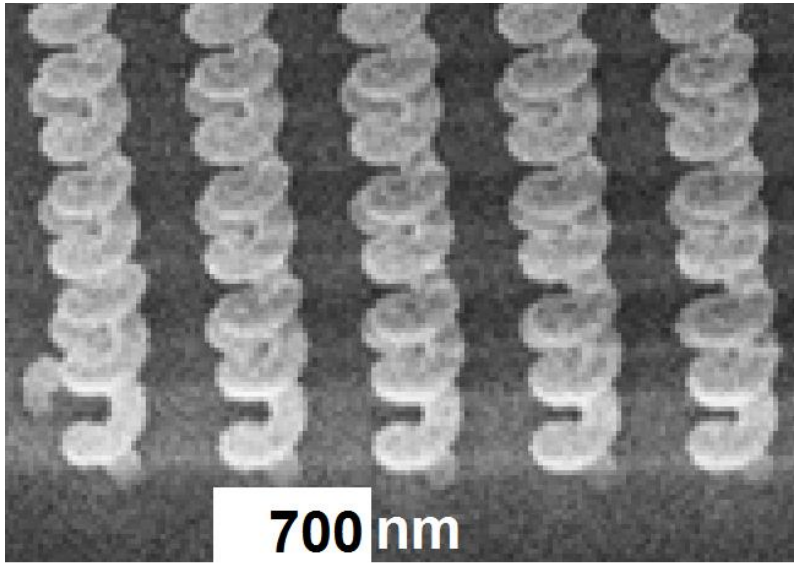


ER=135nm
WR=75nm
VP=310nm
Nt=3.1

OP=700nm



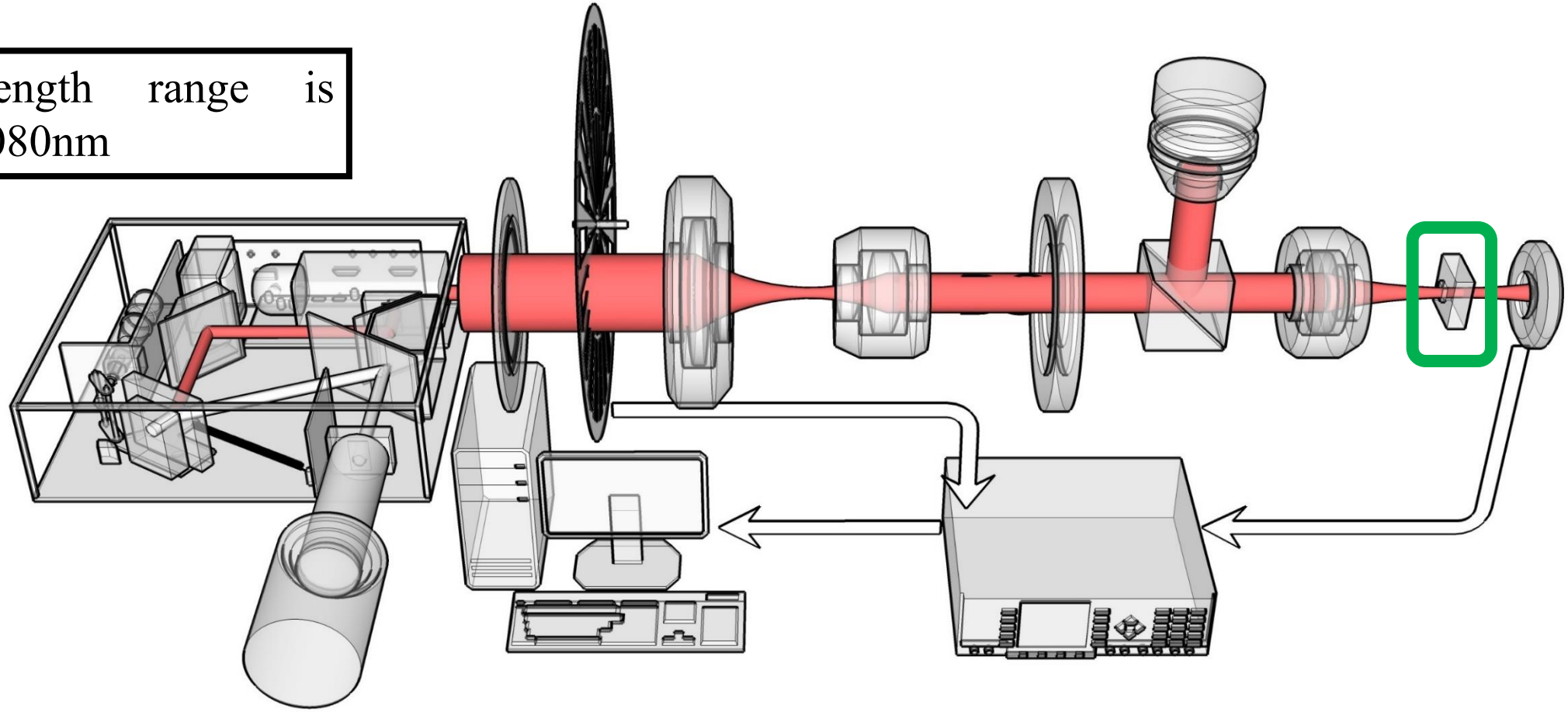




2 – Misure tutto-ottiche e Fotoacustiche

EXPERIMENTAL MEASUREMENTS OF PHOTO-ACOUSTIC SIGNAL IN A CLUSTER OF PT-C NANO-HELICES

Wavelength range is 580-1080nm



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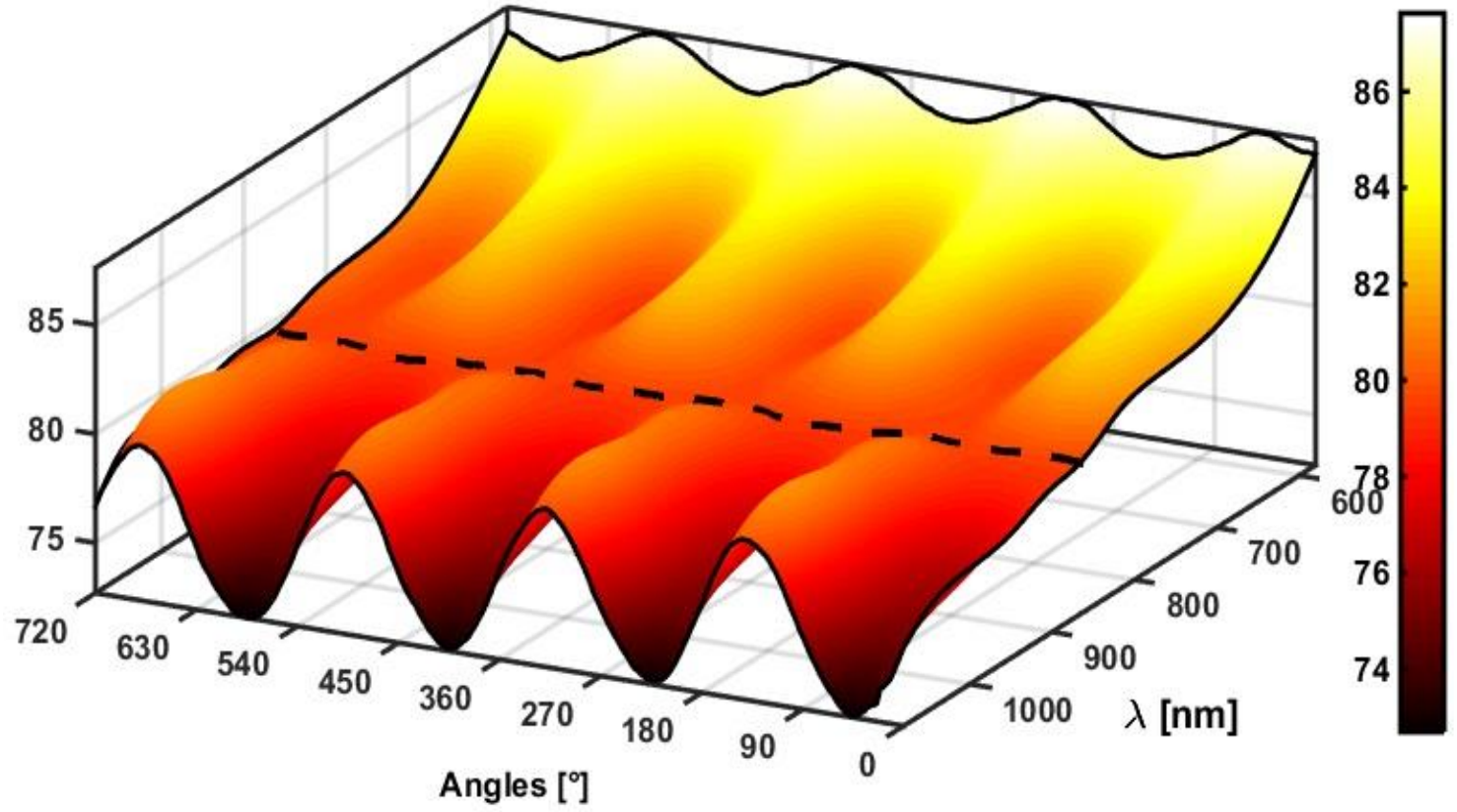
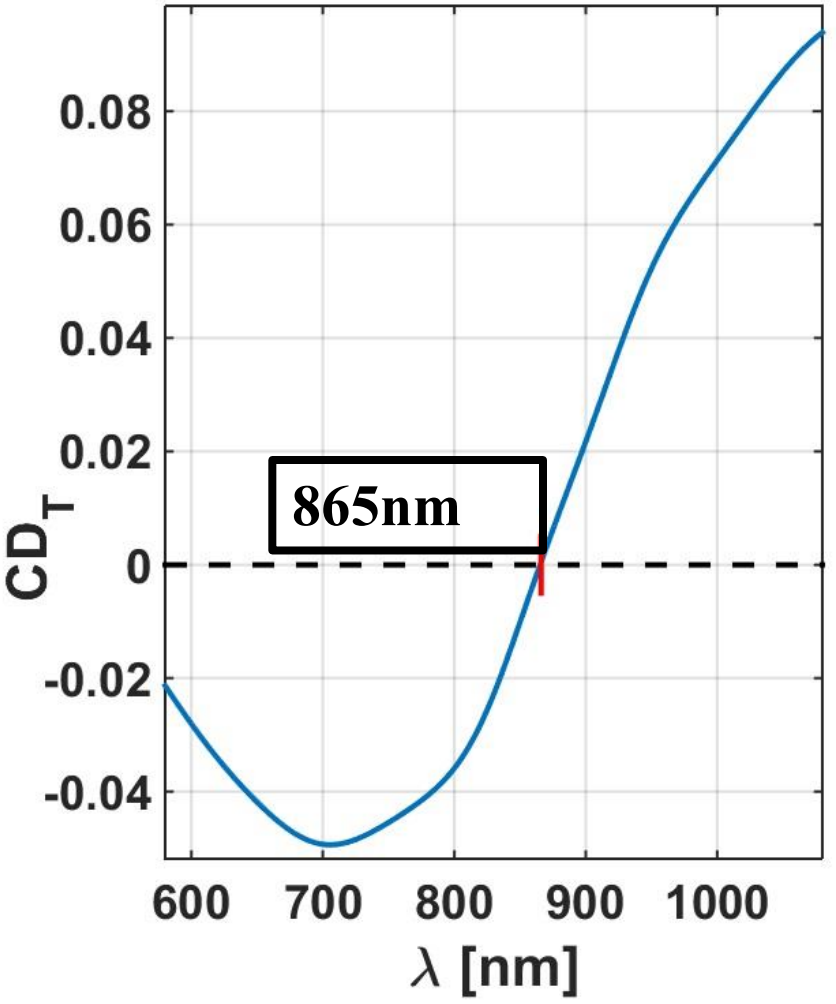


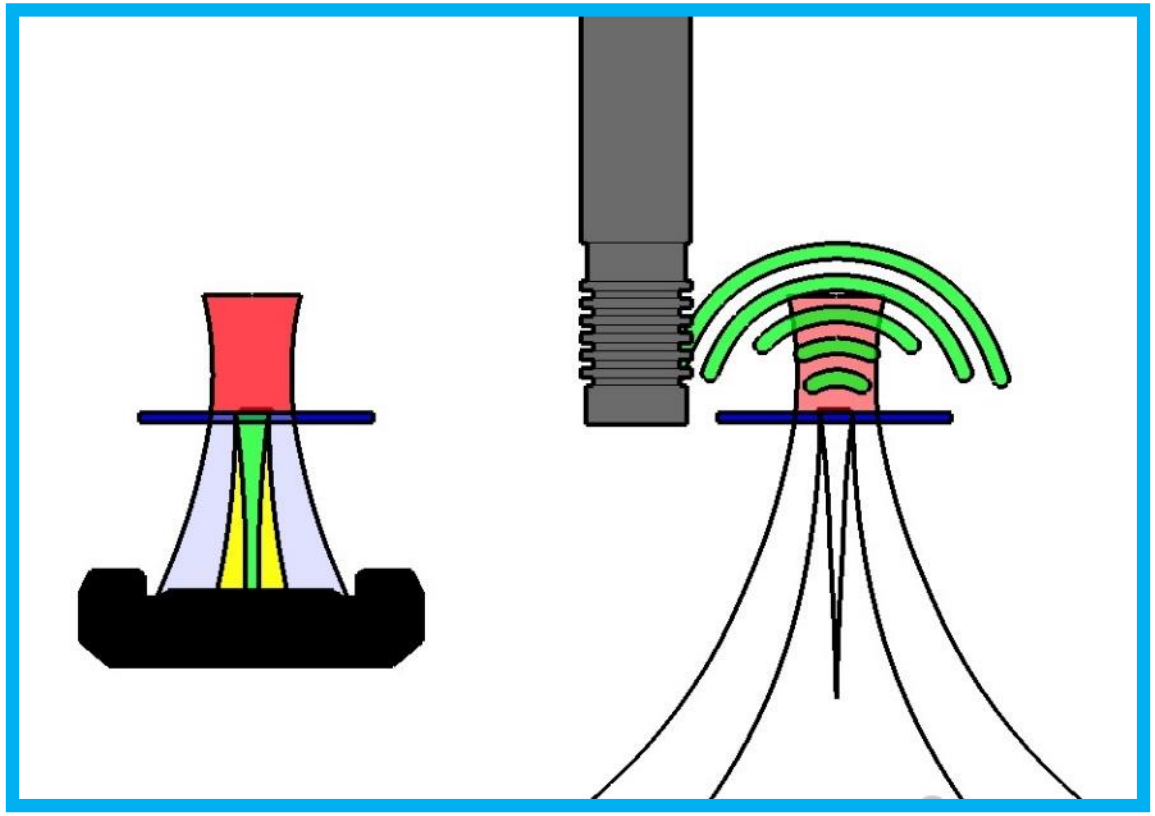


$$\left|E\left(\omega,0,0,-Z_O\right)\right| = a\cdot t_{H+S} + b\cdot t_S$$

$$\rightarrow T = \alpha T_{H+S} + \beta\left|t\right|_{H+S} + \gamma$$

$CD_T = 2*(T_R - T_L)/(T_R + T_L)$

Perché la Fotoacustica?

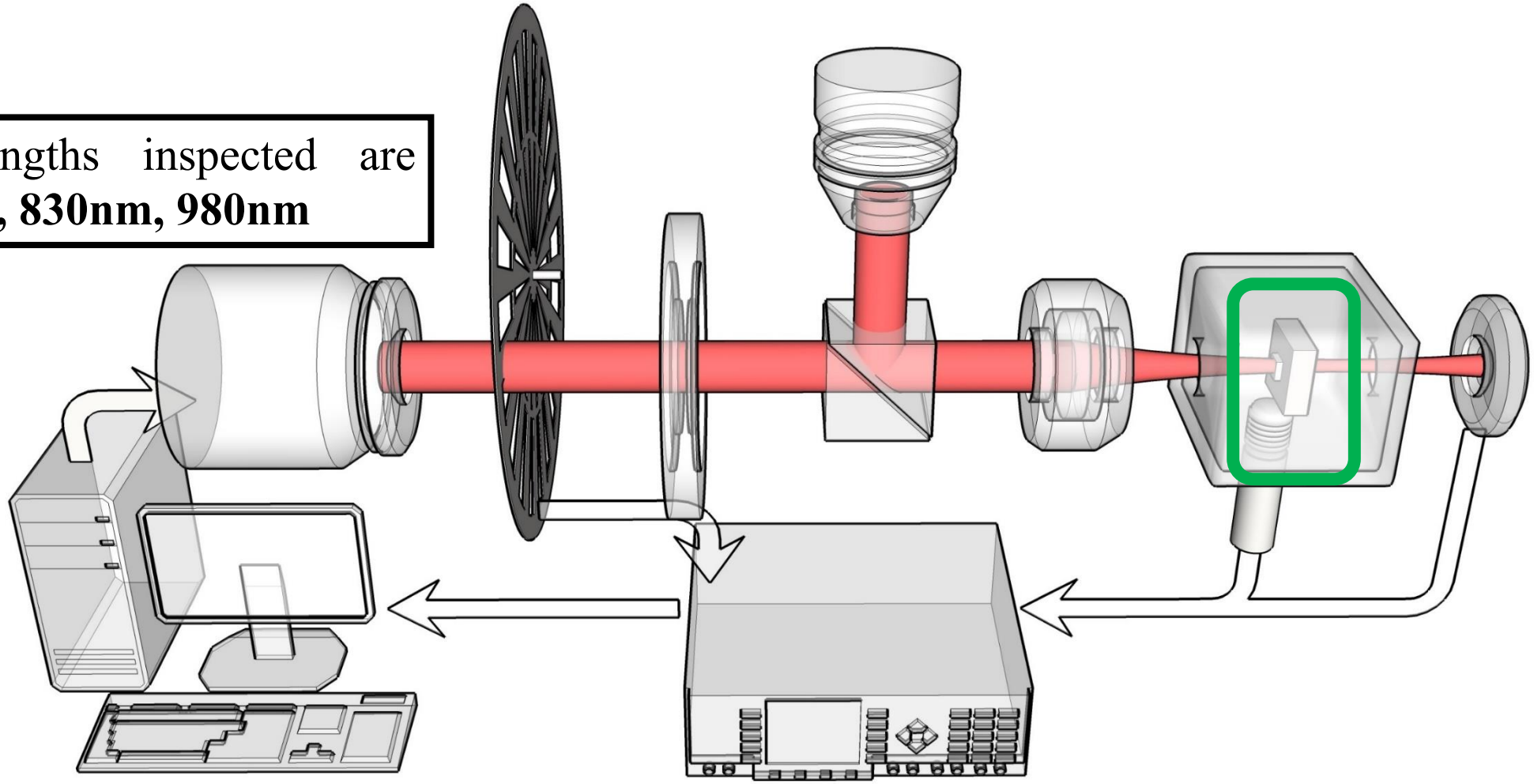


All-Optical (AO) vs Photoacoustic (PA)

$$T = \alpha T_{H+S} + \beta \left| t \right|_{H+S} + \gamma \quad \Rightarrow \quad A = \alpha A\left(T_{H+S}\right)$$

EXPERIMENTAL MEASUREMENTS OF PHOTO-ACOUSTIC SIGNAL IN A CLUSTER OF PT-C NANO-HELICES

Wavelengths inspected are **633nm, 830nm, 980nm**



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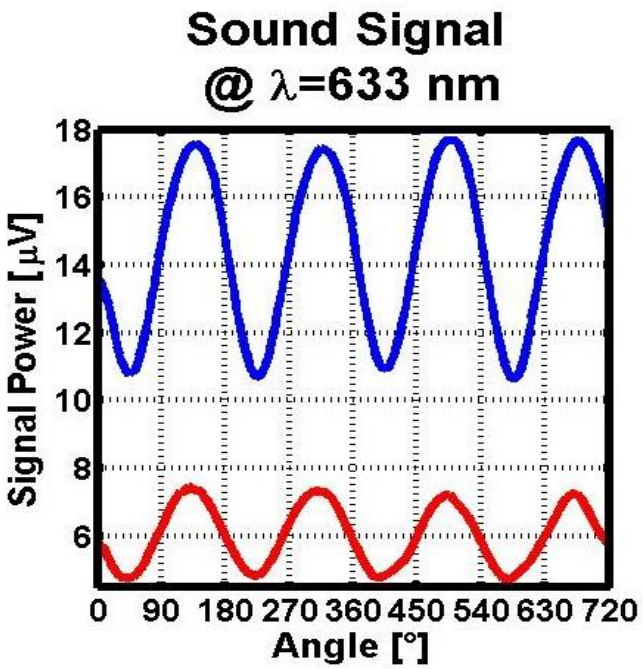
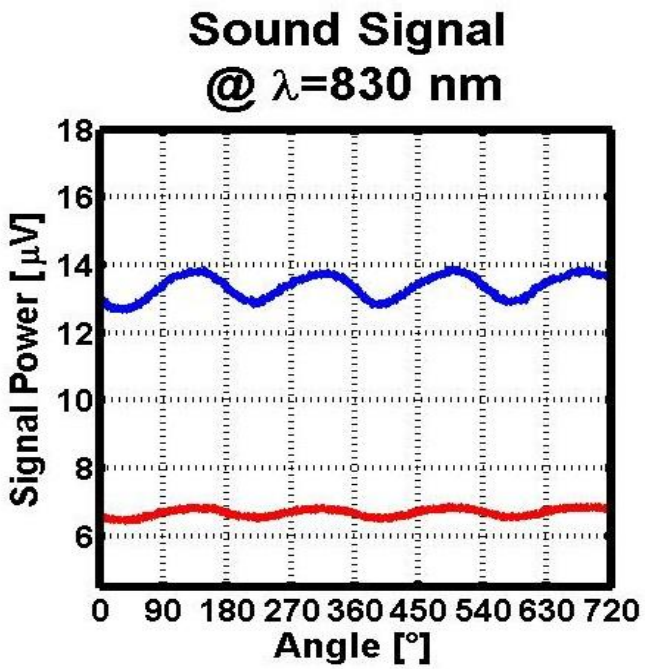
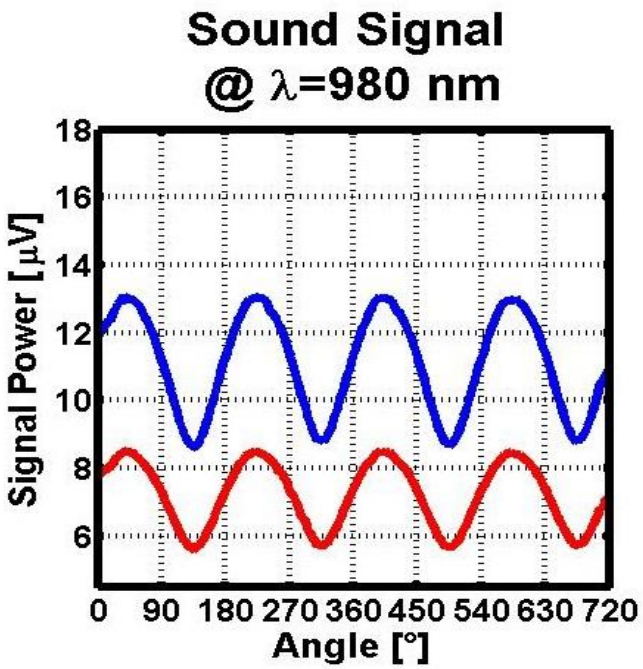




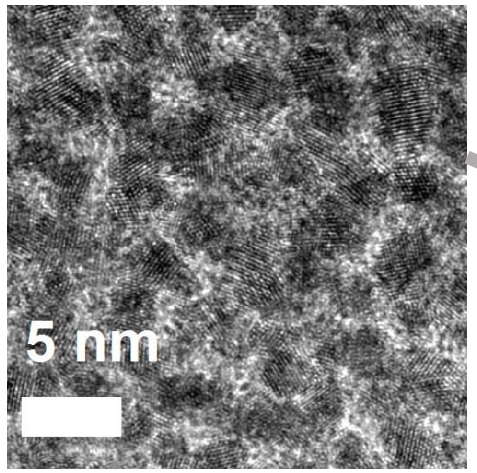


$$CD_A = 2\frac{A_R - A_L}{A_R + A_L} \qquad \begin{cases} +0.36 & @\ \lambda = 633nm \\ +0.10 & @\ \lambda = 830nm \\ -0.25 & @\ \lambda = 980nm \end{cases}$$

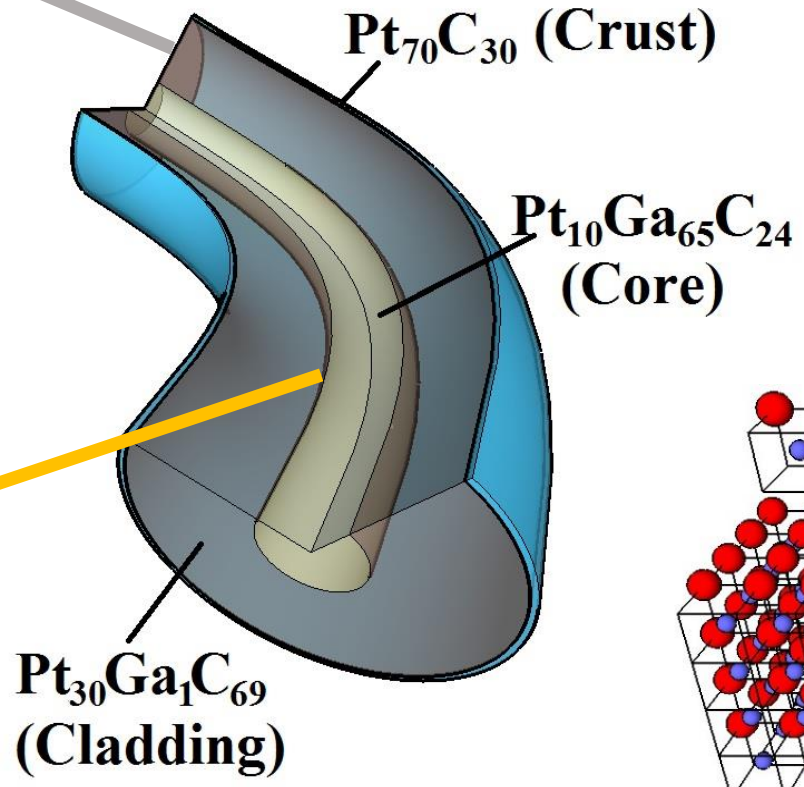
3 – Analisi numerica

3.1 – Metodo di calcolo degli indici rifrattivi

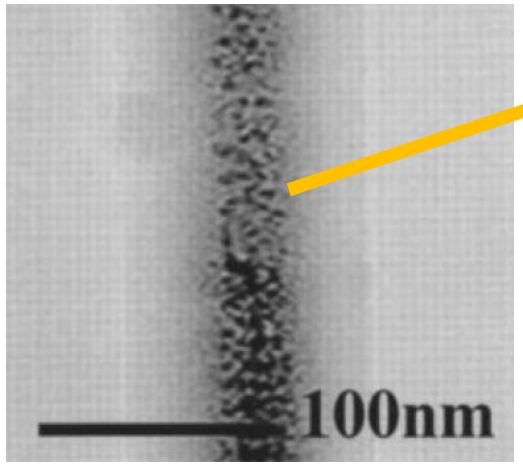
EXPERIMENTAL MEASUREMENTS OF PHOTO-ACOUSTIC SIGNAL IN A CLUSTER OF PT-C NANO-HELICES

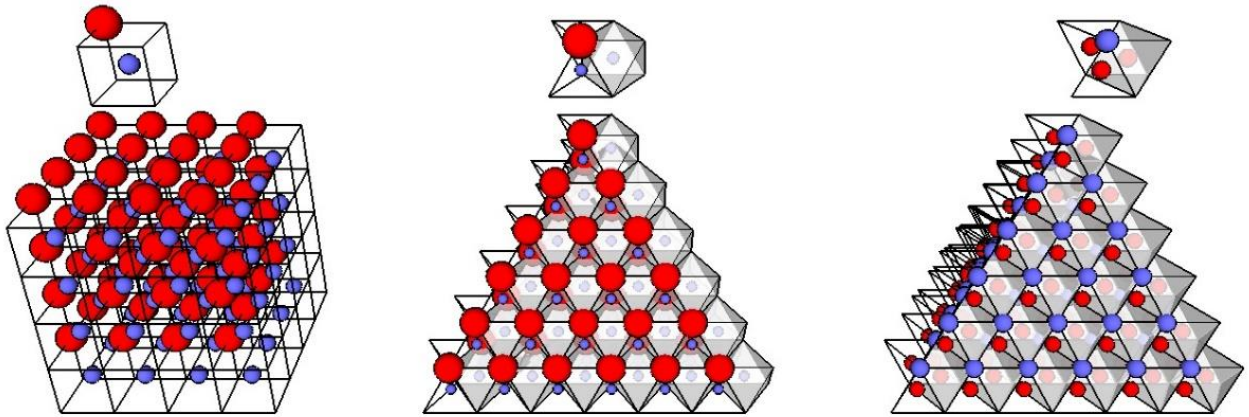


WIRE SECTION SCHEME



R_{IN}=24nm
R_{OUT}=60nm
SKIN=7nm





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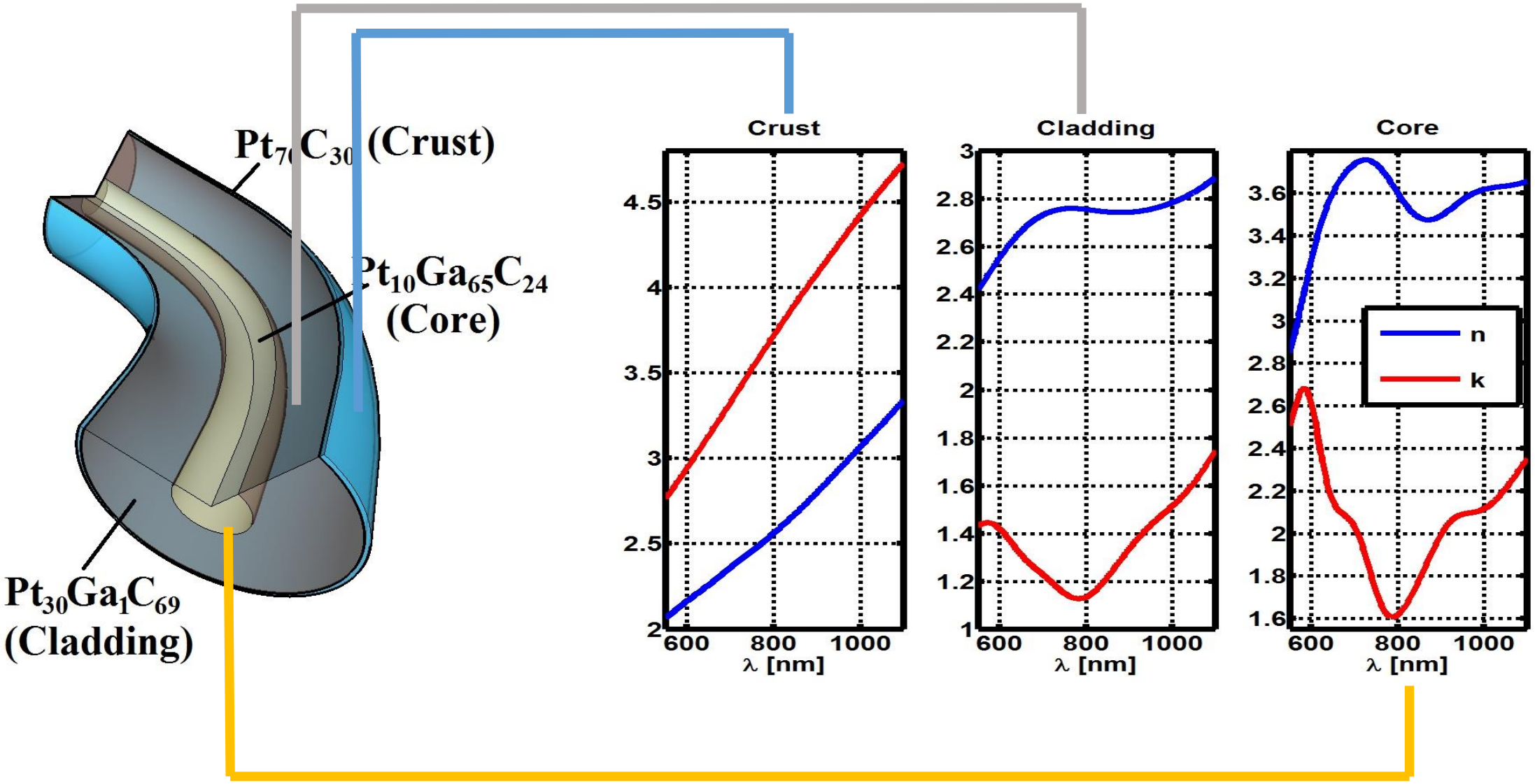

3 – Analisi numerica

3.2 – Simulazioni dei campioni

EXPERIMENTAL MEASUREMENTS OF PHOTO-ACOUSTIC SIGNAL IN A CLUSTER OF PT-C NANO-HELICES

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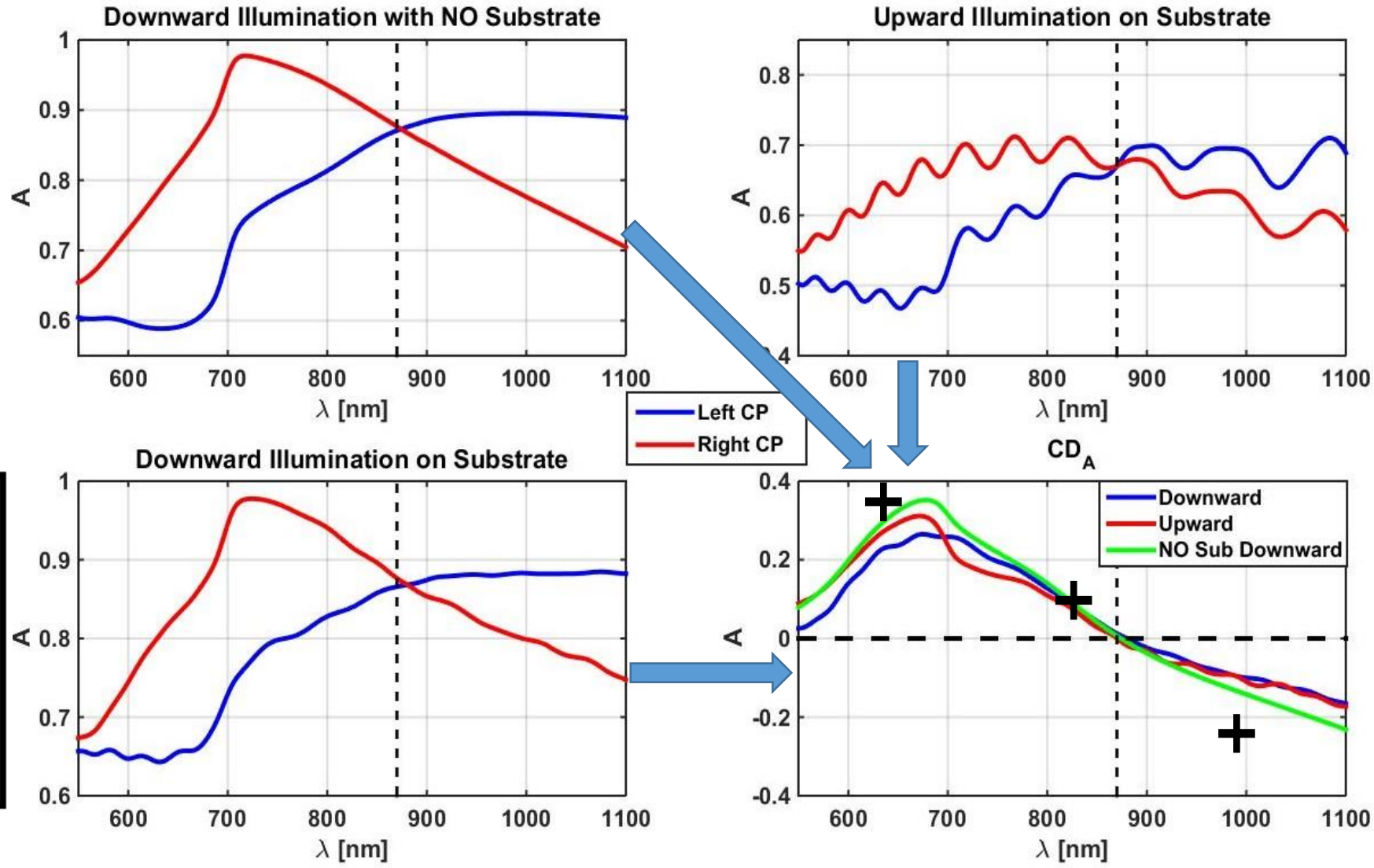
$$\frac{CD_A^{\downarrow}(\lambda)}{CD_A^{\uparrow}(\lambda)} \approx \frac{1-\frac{(1-R_H)R_S}{1-R_S^2}}{\left[1+\frac{(1-R_H)R_S}{1-R_S^2}\right]-\frac{2R_S}{1-R_S^2}\frac{A_{H,R}\cdot A_{H,L}}{A_{H,R}+A_{H,L}}} \approx 1$$



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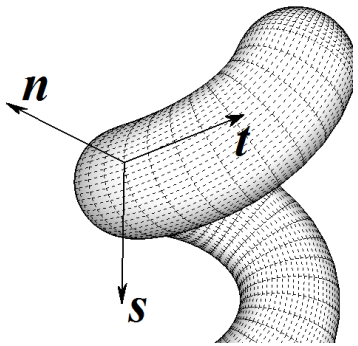

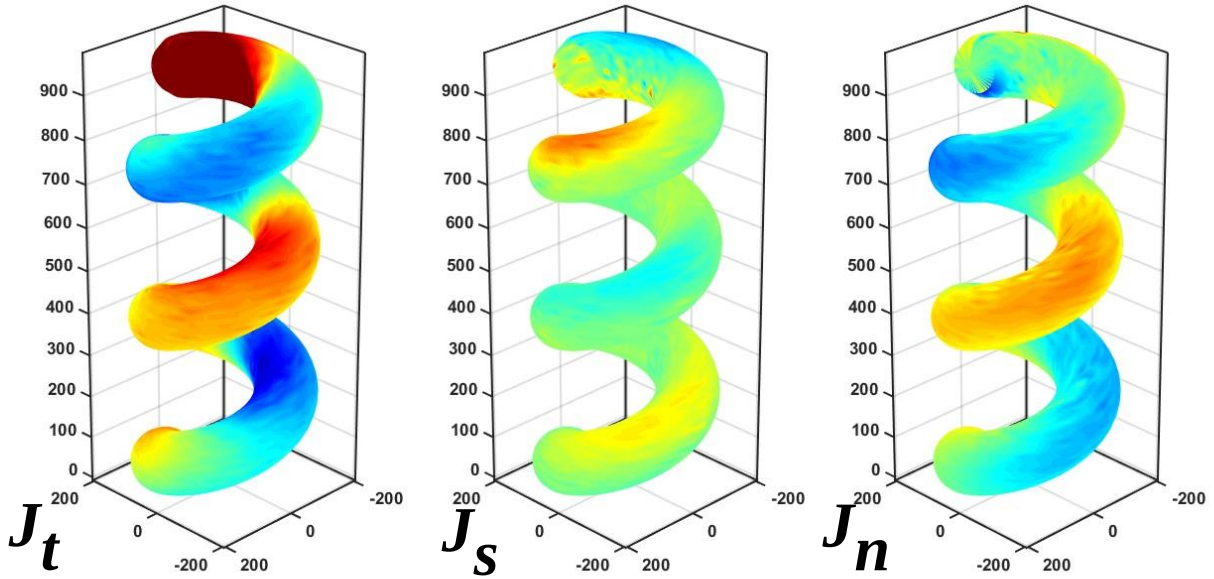

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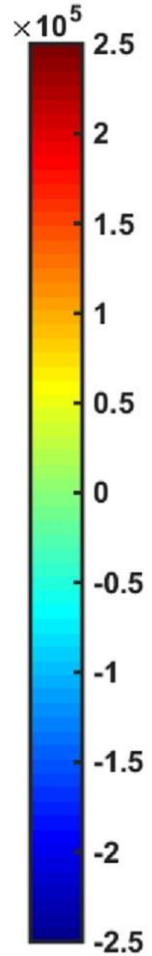
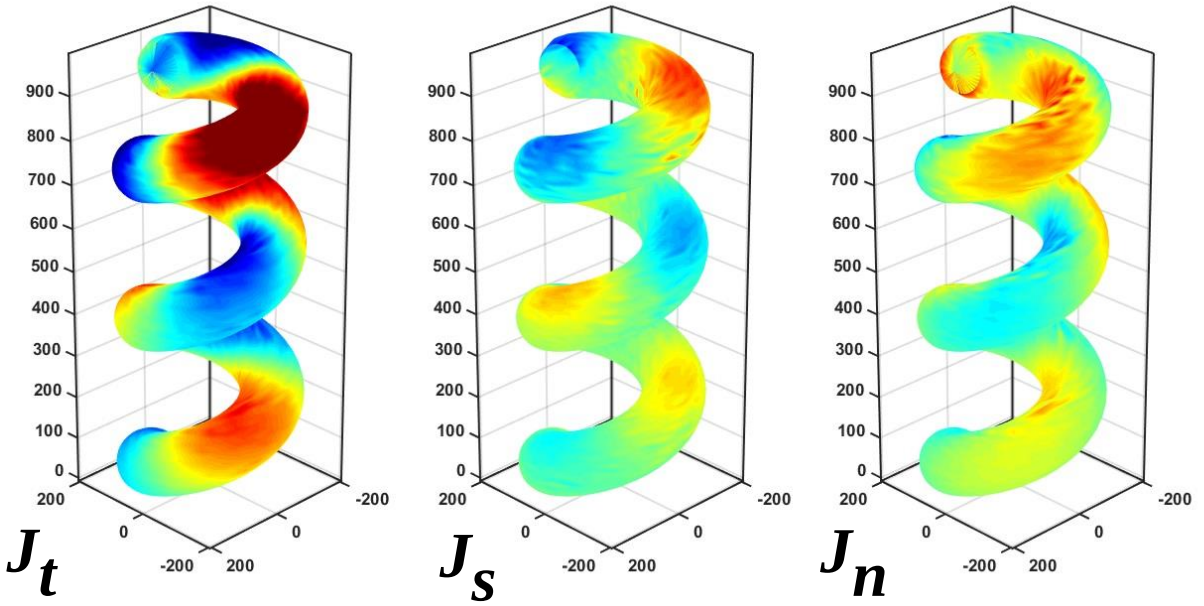


λ=633nm



RIGHT

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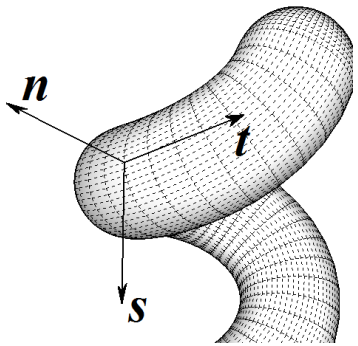

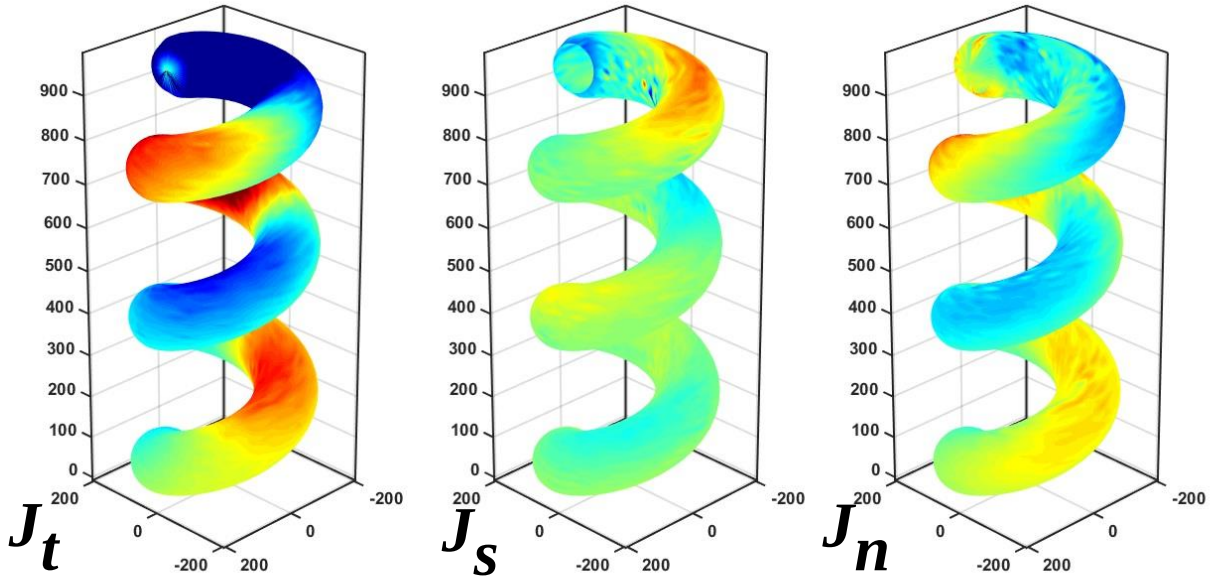

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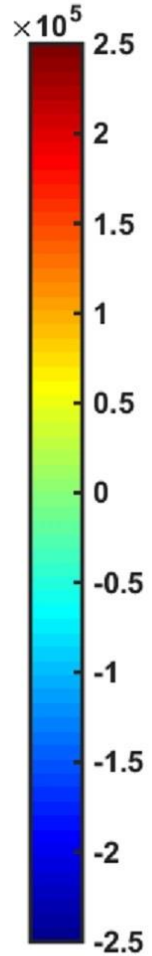
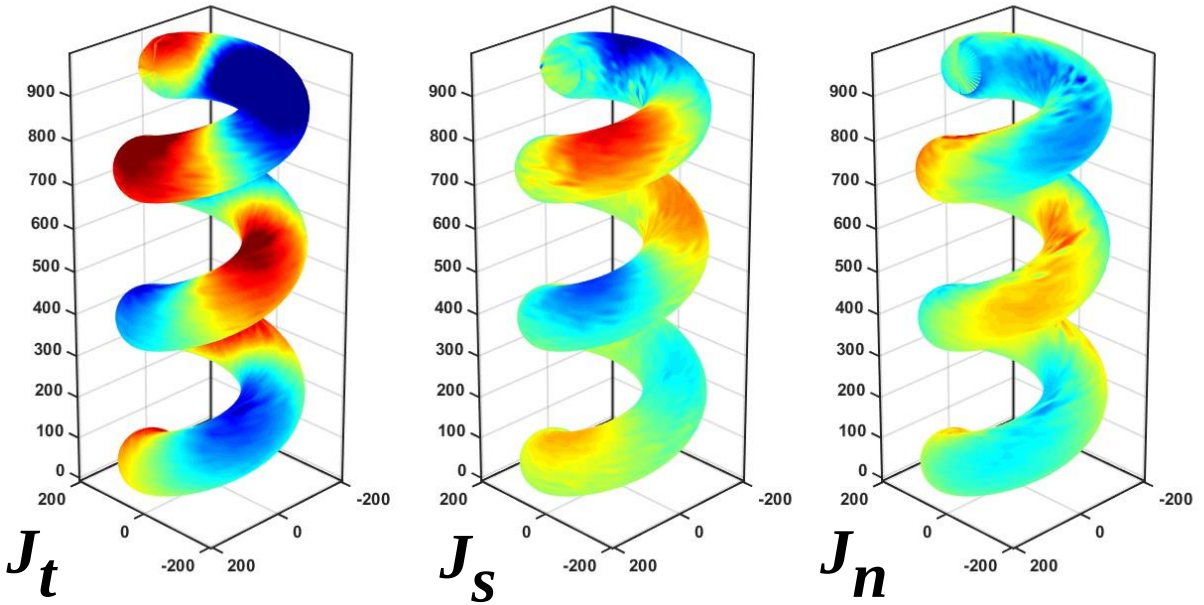


λ=830nm



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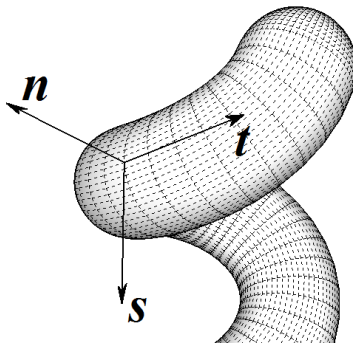

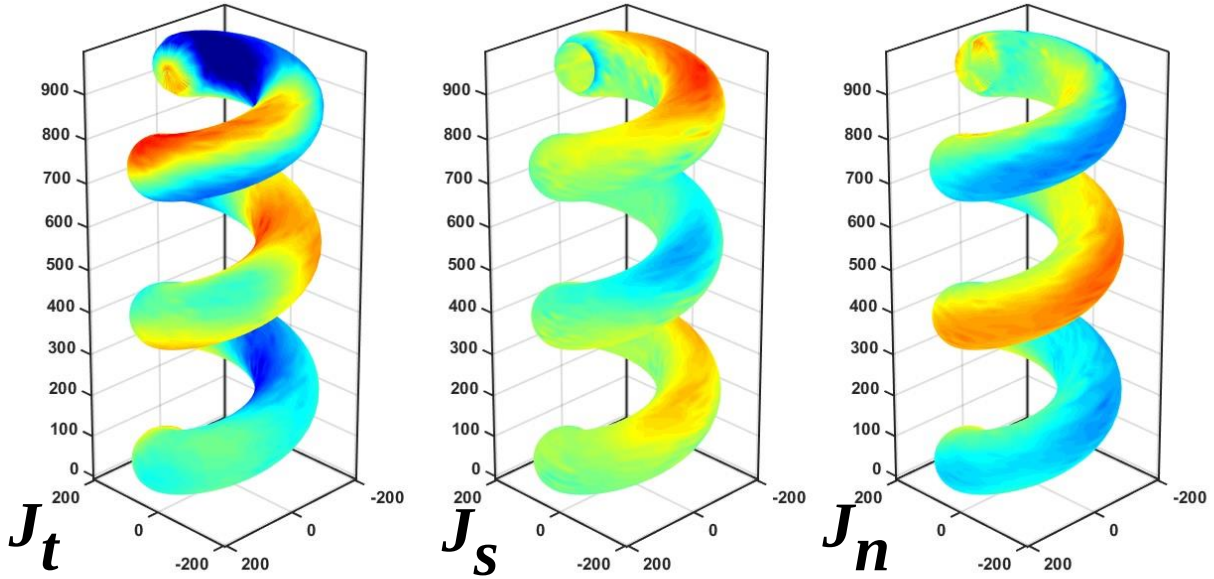

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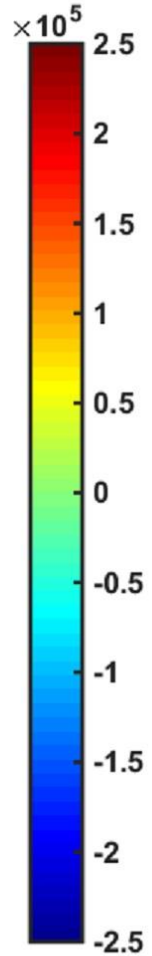
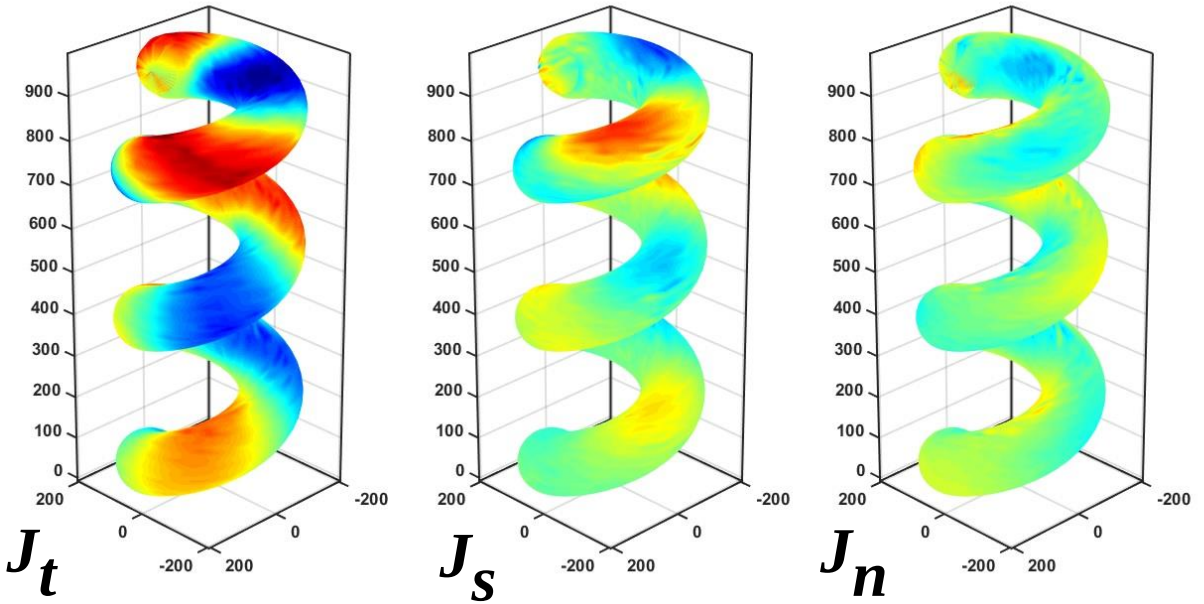


λ=980nm



RIGHT

CONCLUSIONI

1 – Ottima corrispondenza tra dati sperimentali tutto-ottici, fotoacustici e risultati delle simulazioni numeriche

2 – Buona padronanza ingegneristica per la risposta elettromagnetica delle strutture progettate e realizzate: è possibile tunare le eliche dall'UV al Far IR

3 – Sono in corso analisi nonlineari (sperimentali e teoriche) sulle strutture: alti livelli di illuminazione hanno mostrato alterazioni della risposta fotoacustica (Work In Progress…)

4 – Possibilità di integrare campioni più estesi in dispositivi come filtri ottici per l'intrattenimento video ludico e dispositivi miltiari.

RICONOSCIMENTI

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