Società Chimica Italiana
Divisione di Didattica Chimica

Convegno 2019 della Divisione di Didattica della SCI

ITIS Rossi 1878

Le Nanotecnologie nella Scuola Secondaria di Secondo Grado: Sintesi e studio di un Sensore per Cationi

Prof. Renato Bonomi
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Bologna, 03/12/2019

Il contesto

Materie: Chimica Organica - Chimica Analitica (A.S. 2017-2018)

Scuola: ITI Indirizzo Chimica - Chimica e Materiali

Classi: Triennio Indirizzo Chimico

Argomento → Sviluppo di un sensore per cationi

- **Attività di «ricerca» guidata dal docente con un piccolo gruppo di studenti**
- **Ideazione di una nuova esperienza di laboratorio**

Occasione

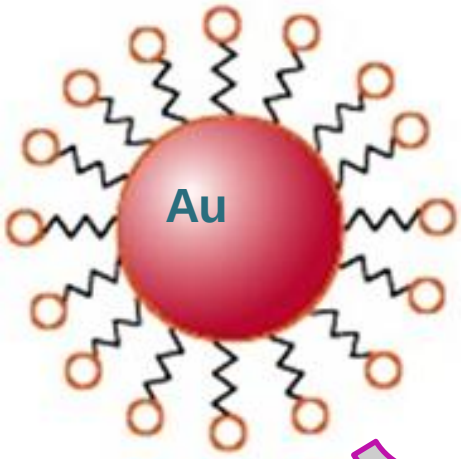
Progetto "Laboratori Aperti"

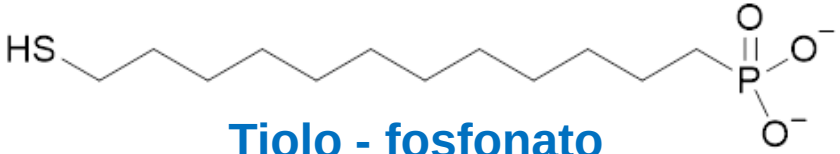
Laboratori aperti al pomeriggio per alcuni studenti motivati (su base volontaria)

Attività organizzata dal Dirigente Scolastico per favorire la motivazione degli studenti e i rapporti della scuola con il territorio

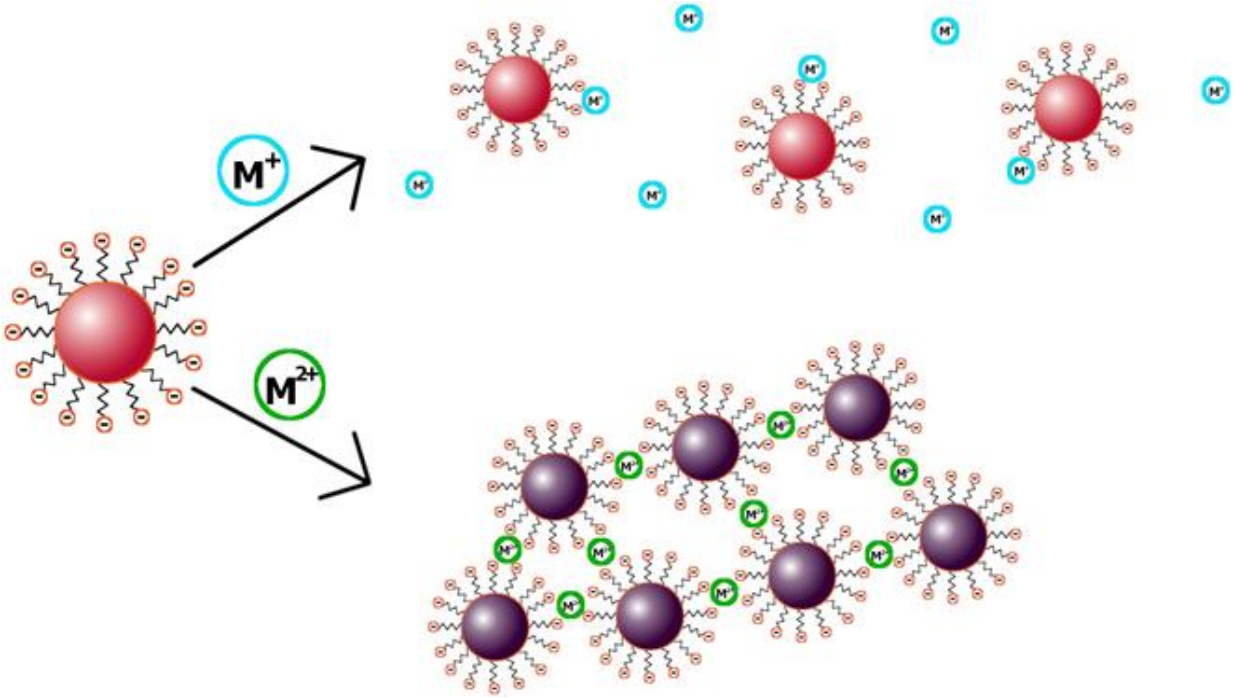
Desiderio di innovare la didattica e l'offerta formativa, mettendo al centro lo studente e la sua creatività

Il progetto





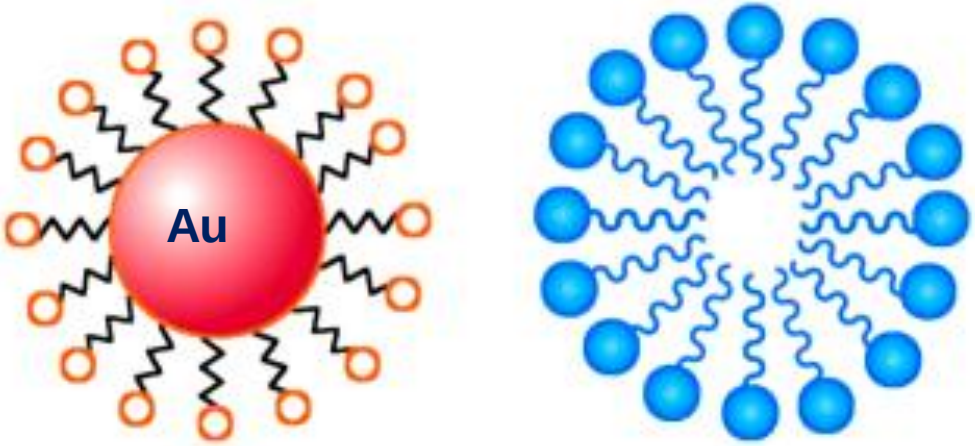
Tiolo - fosfonato Commerciale



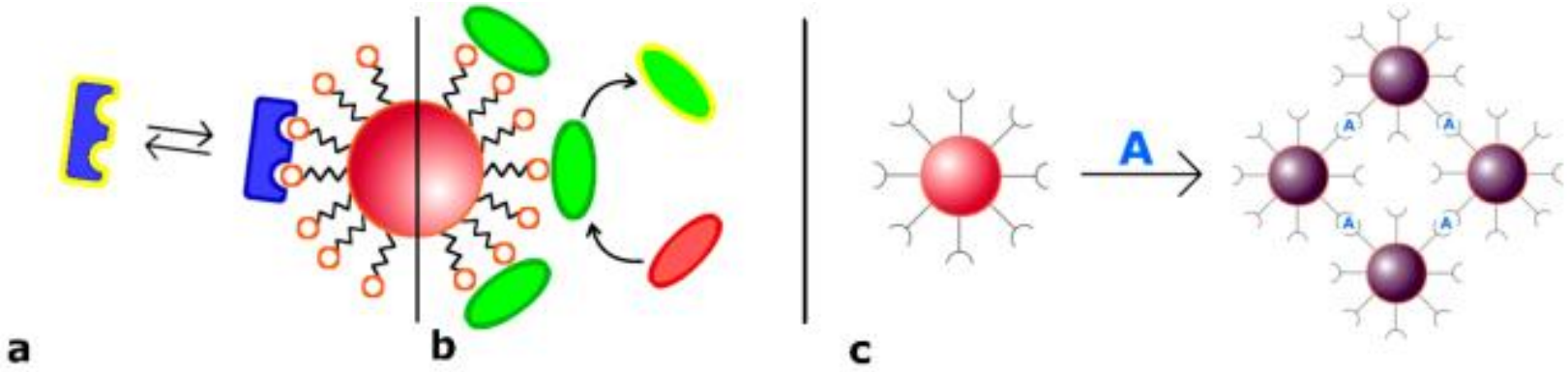
Prima parte / Attività di Ricerca

Le nanoparticelle d'oro

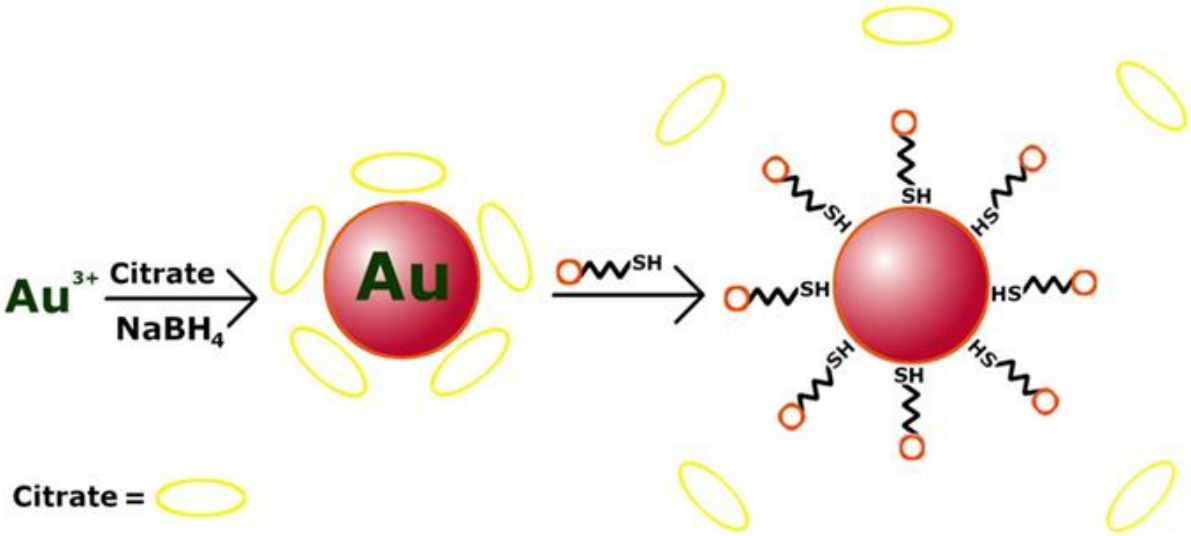
Struttura

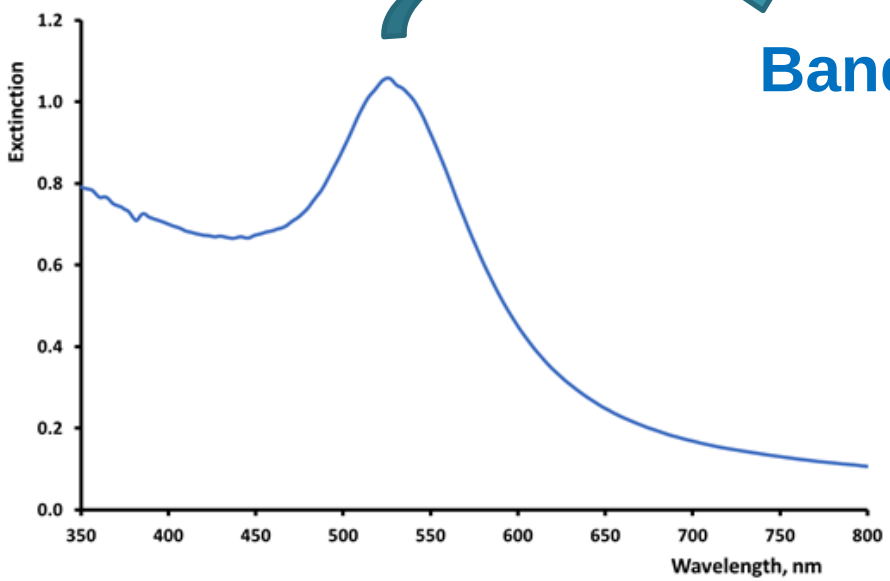


Utilizzo come sensore chimico



Sintesi delle nanoparticelle d'oro

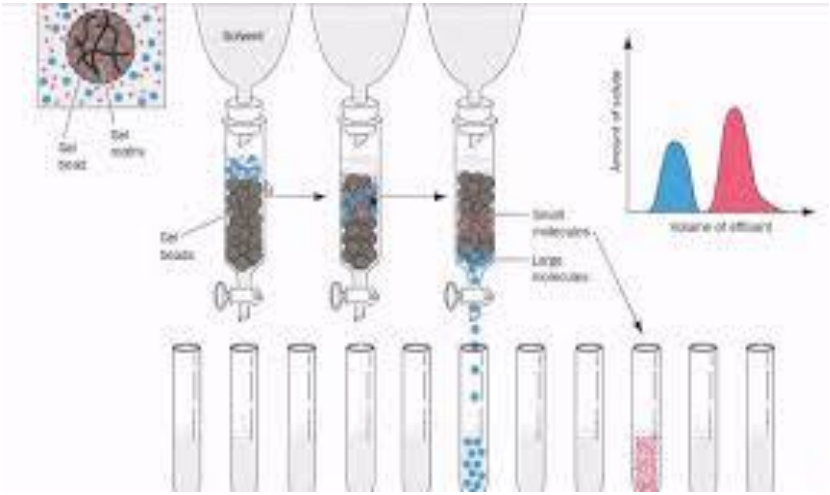


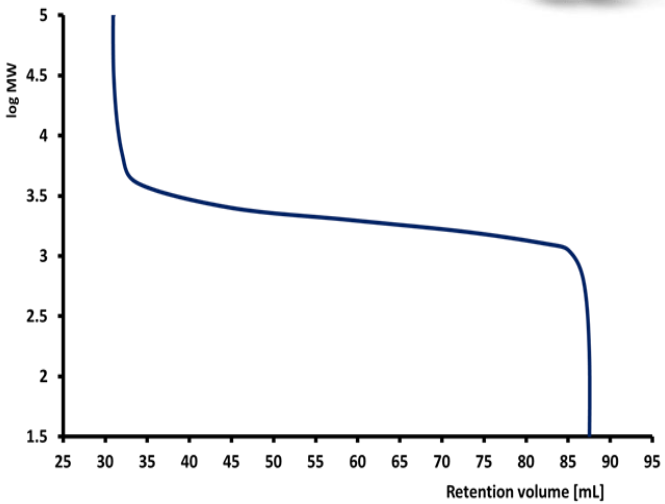


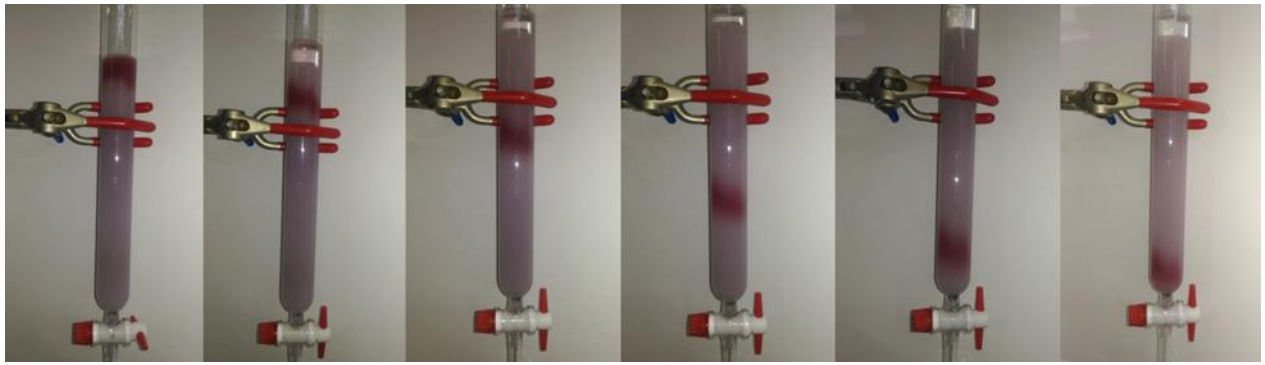
Banda plasmonica

$\varepsilon \approx 10^{8}\ cm^{-1}\ M^{-1}$

Purificazione nanoparticelle d'oro (GPC)

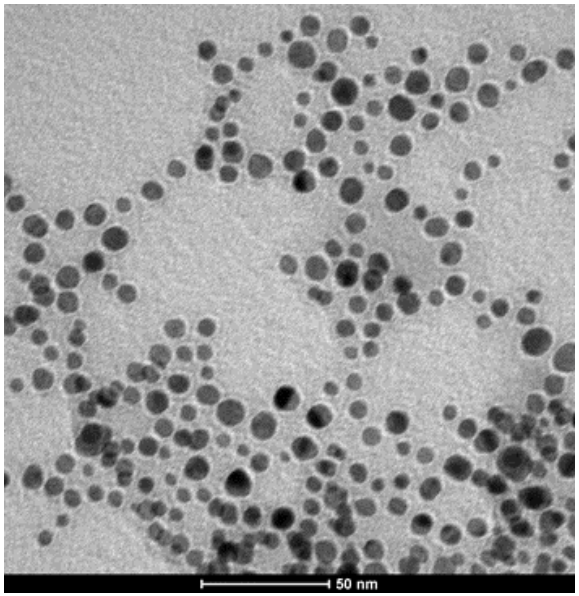


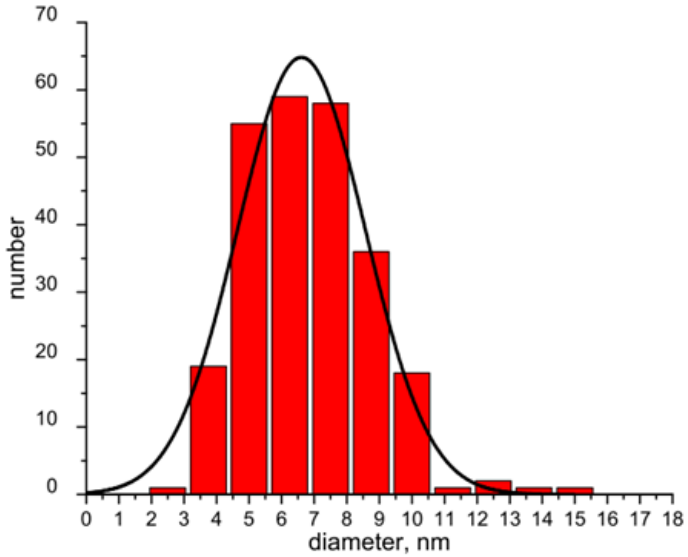




Resina Sephadex G-25, eluente acqua

Caratterizzazione delle nanoparticelle



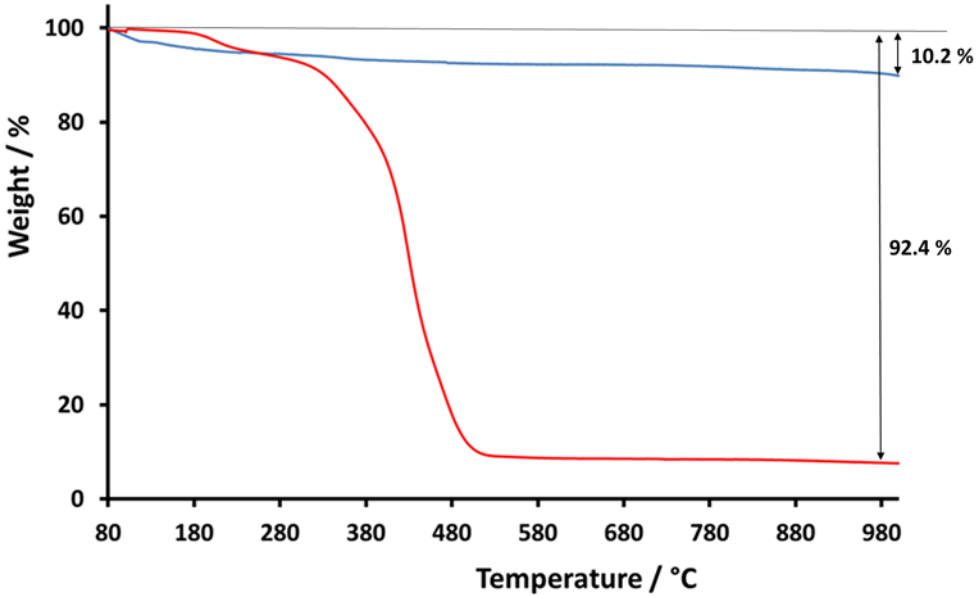


TEM

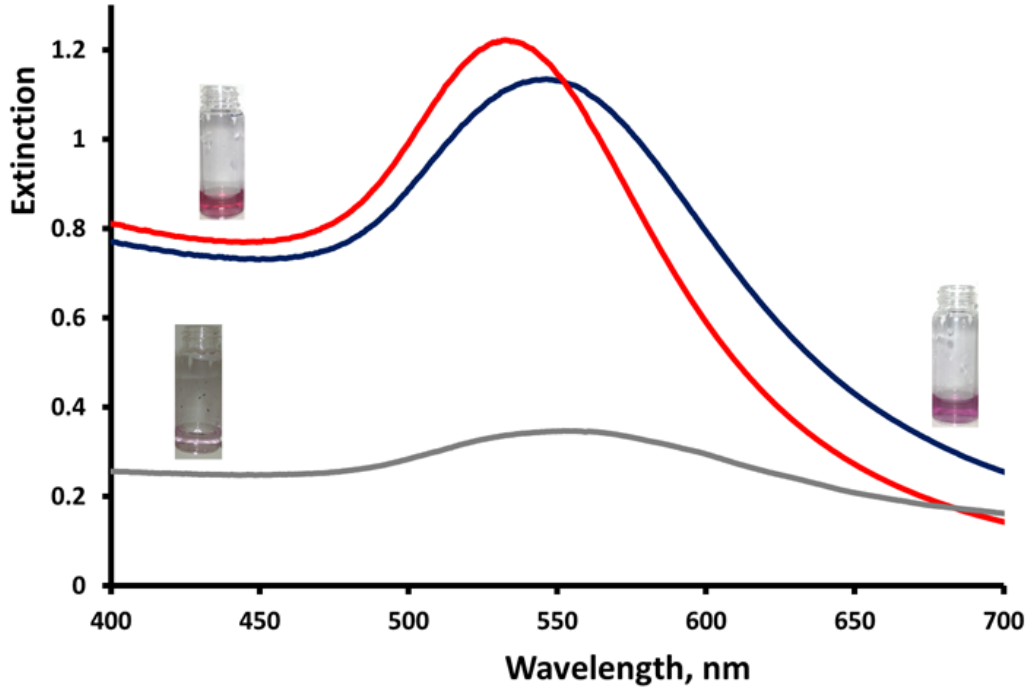
TGA

UV-Vis

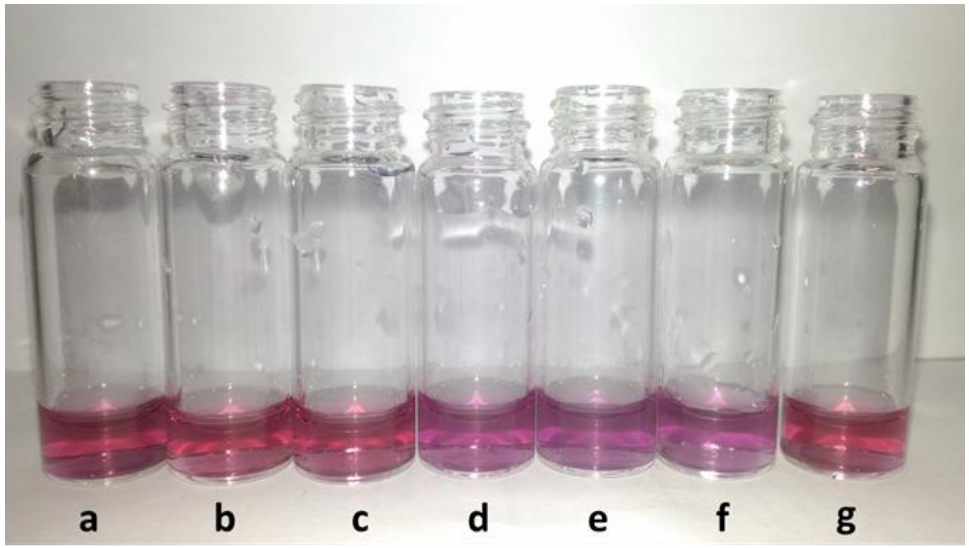
∅ = 6.6 ± 1.8 nm



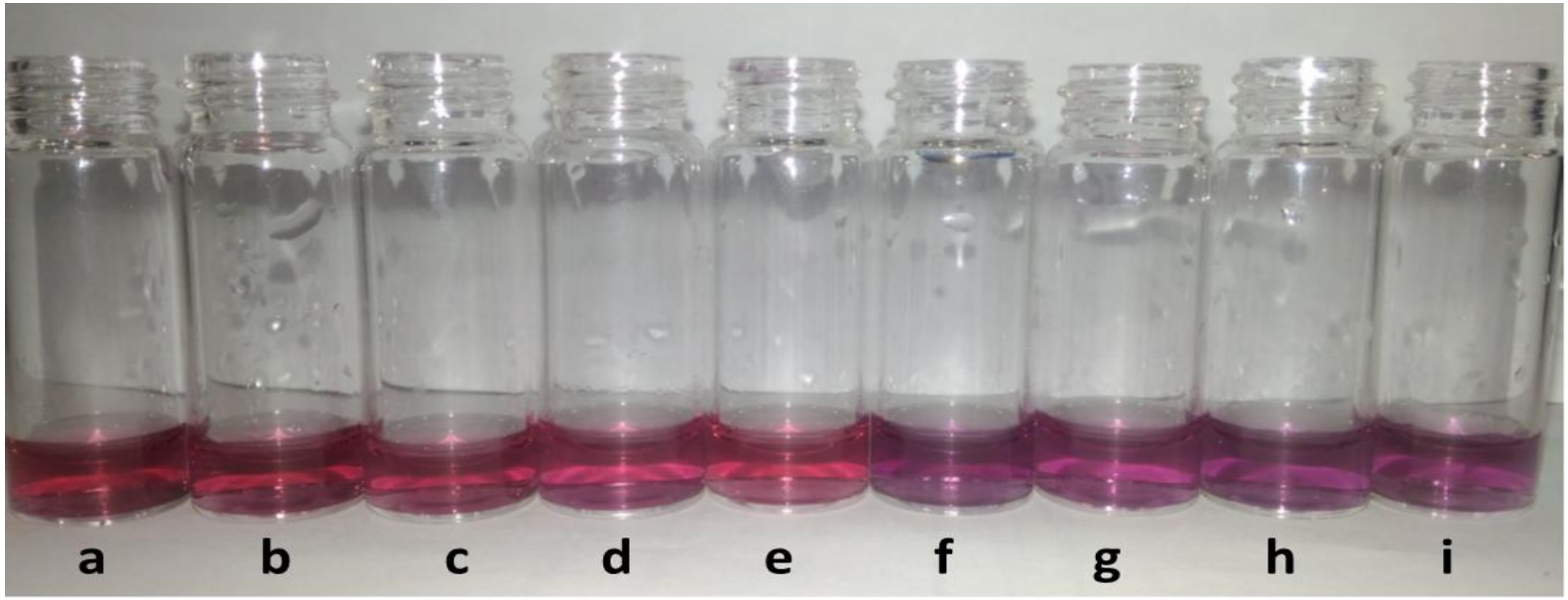
Test (aggiunta di Mg^{2+})



2.0×10^{-6} M (a)
2.0×10^{-5} M (b)
2.0×10^{-4} M (c)
2.0×10^{-3} M (d)
2.0×10^{-2} M (e)
2.0×10^{-1} M (f)



Test (aggiunta di altri ioni, 5.0×10^{-4} M)

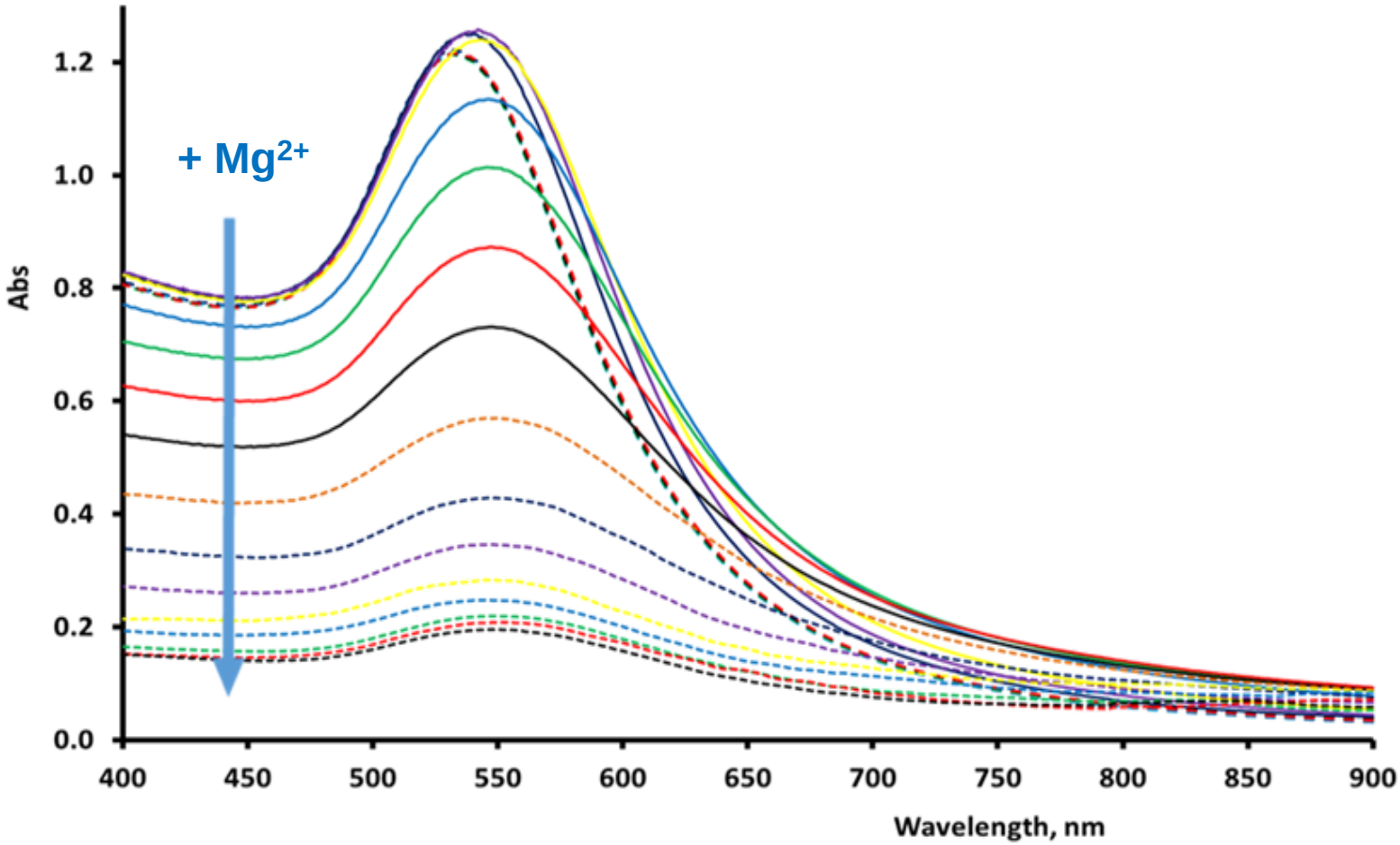


Na^+ K^+ Li^+ Al^{3+} Zn^{2+} Ca^{2+} Pb^{2+} Mg^{2+}

Cationi bivalenti

[ione] = 5.0×10^{-3} M

Titolazioni all'UV-Vis / Affinità



Seconda parte / Didattica

Esperienza di laboratorio

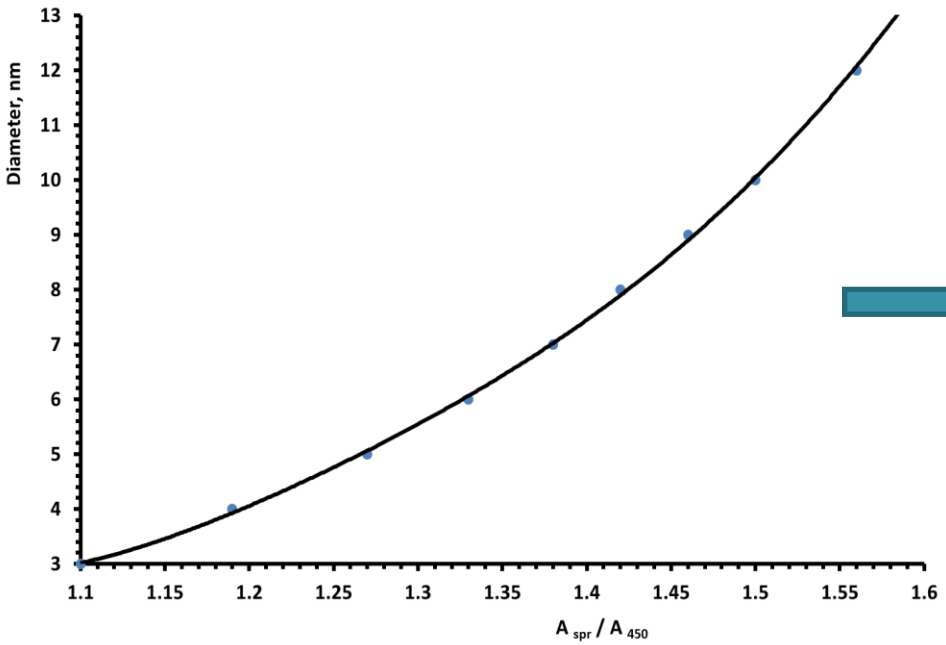
E' stata redatta una metodica di laboratorio tarata per una classe quinta

Tempi: 3 sessioni di 2 ore ciascuna

- Sintesi nanoparticelle
- Purificazione e caratterizzazione
- Saggi su cationi noti e saggio incognito

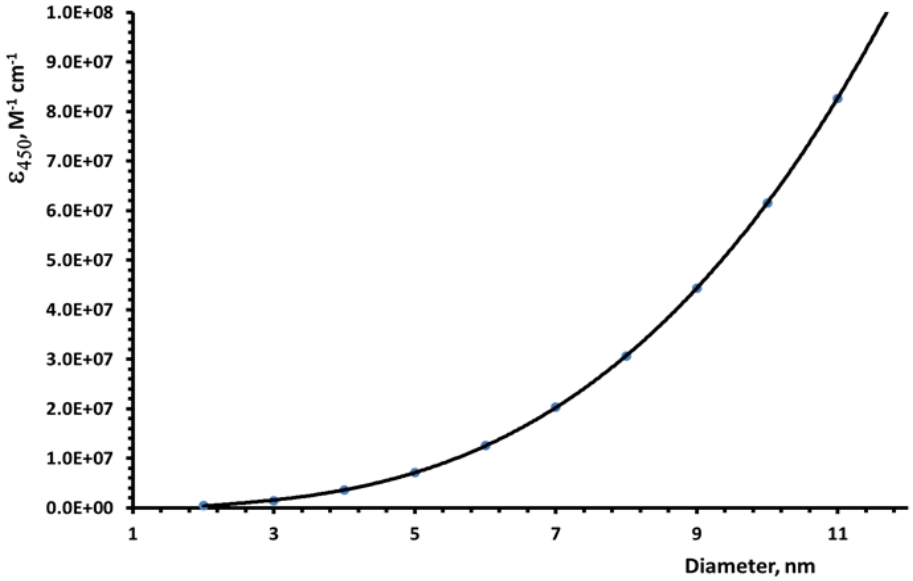
→ Risposta alle domande-guida

Percorso guidato



Determinazione delle dimensioni

Determinazione della concentrazione



Anal. Chem. **2007**, 79 (11), 4215-4221

Percorso guidato

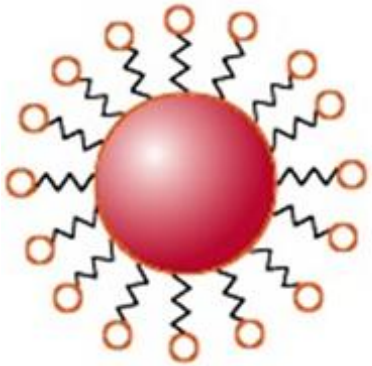
Dimensioni
(UV-Vis)

Area superficiale e volume del core

Formula minima
$Au_{8880}(RSH)_{752}$

Concentrazione di nuclei d'oro (≈ 75 nM)

Concentrazione di tioli (≈ 55 μM)



ACS Nano **2013**, 7 (2), 1129-1136

Risultati / Test

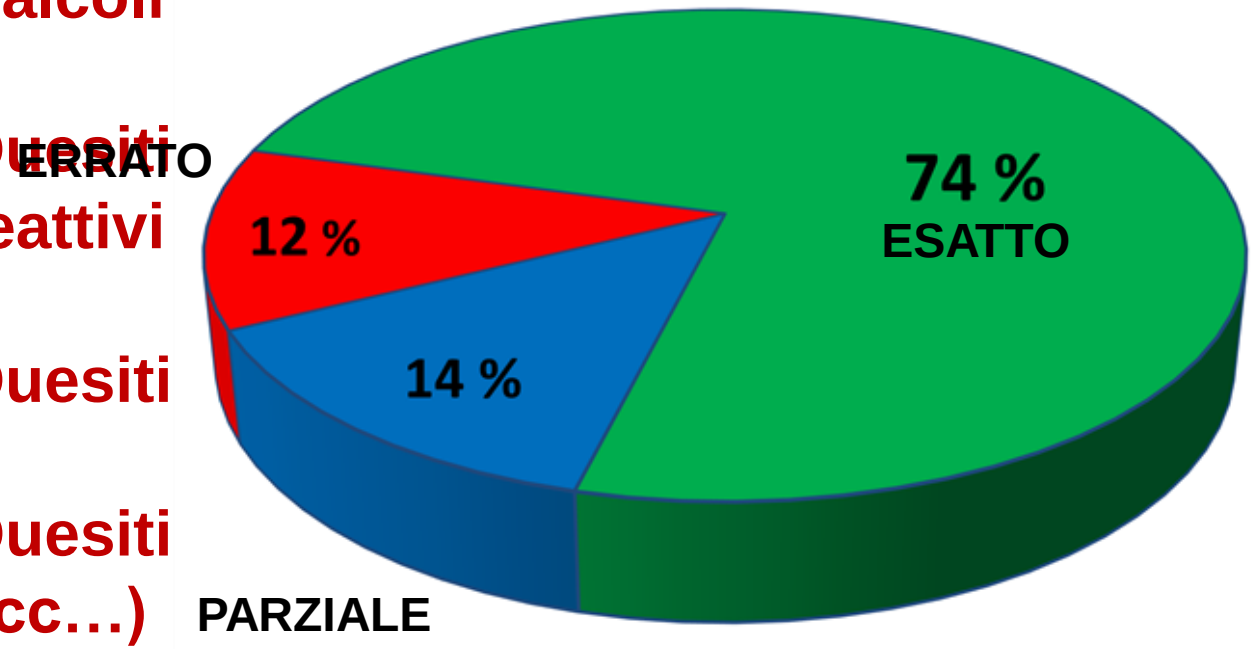
Al termine dell'attività pratica è stato somministrato un test con 11 quesiti a risposta aperta

Calcoli **elle**

Quesiti **dei**
reattivi

Quesiti

Quesiti **i, pH**
ecc…)



Quesito sul lavaggio della vetreria

Pro / Contro

Vantaggi

Argomento moderno e accattivante
Utilizzo di più tecniche analitiche
Poco costoso ≈ 3.5 euro/studente
Multidisciplinare

Svantaggi

Organizzazione del lavoro (tempi e spazi)
Buona manualità
Laboratorio abbastanza attrezzato

Perché non pubblicarlo?

JOURNAL OF CHEMICAL EDUCATION

Laboratory Experiment

pubs.acs.org/jchemeduc

Synthesis, Purification, and Characterization of Negatively Charged Gold Nanoparticles for Cation Sensing

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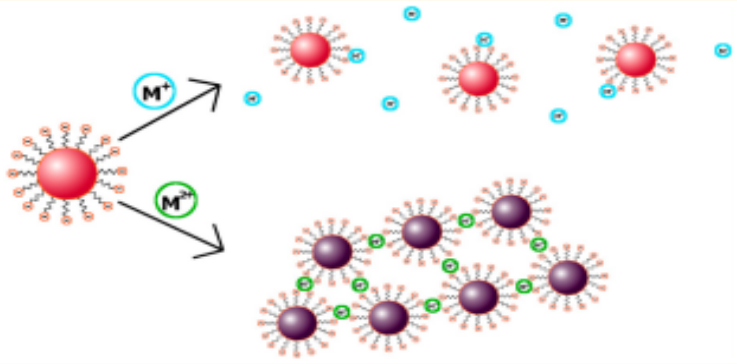
Supporting Information

ABSTRACT: In recent years, nanotechnology has been one of the major subjects of scientific and technological research. Currently, several applications of nanotechnologies are already available on the market. Particularly relevant are the fields of new materials and sensors, which have excellent potential future applications in the biomedical field. This paper describes a project in which the students were challenged to investigate the properties of gold nanoparticles they synthesized themselves. The activity, suitable for students with good chemical knowledge (last year of high school), is divided into three parts, each taking 2 h. In the first part, gold nanoparticles are synthesized and functionalized. In the second, students purify the sample and analyze its optical properties, focusing on the noncovalent interaction with metallic ions. Last (part three), the students realize a chemosensor for cations using the nanoparticles synthesized. At the end of the project, students use the sensing system they had set up to analyze an unknown sample containing bivalent or monovalent metal cations. The proposed activity turned out to be strongly motivating for the students involved and definitely improved their knowledge in the nanomaterials field. Different analytical techniques, such as UV−vis spectrometry, GPC, and TGA, were used, and consequently, both the understanding and the ability to use them were reinforced.



KEYWORDS: *High School/Introductory Chemistry, Analytical Chemistry, Inquiry-Based/Discovery Learning, Nanotechnology, Qualitative Analysis, Surface Science, UV−Vis Spectroscopy*

J. Chem. Edu. 2019, 96 (10), 2292-2299

Conclusioni

Obiettivi Raggiunti

- Ottenimento di una nuova esperienza di laboratorio
- Acquisizione del metodo scientifico
- Multidisciplinarietà (chimica, matematica, logica)
- Pubblicazione internazionale (curriculum, peer review)
- Rendere gli studenti partecipi e responsabili del loro apprendimento
- Applicazione delle conoscenze in un nuovo contesto (competenze)
- Gestire tempi e risorse

Ringraziamenti

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Prof.ssa Lavinia Vettore
Prof.ssa Federica Stazi
Dr. Daniele Rosa Gastaldo
Assistente: Nicoletta Gaiga

Prof.ssa Paola Baron Toaldo

…e a tutti gli studenti che hanno partecipato con assiduità, dedizione e passione