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Role of Solid Impurities on the Non-Photochemical Laser Induced Nucleation of Ethylenediamine Sulfate solutions

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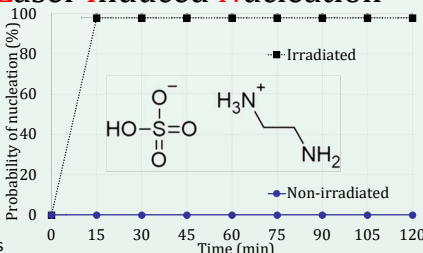
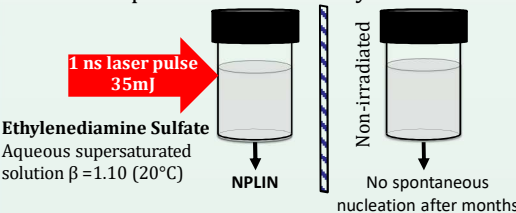
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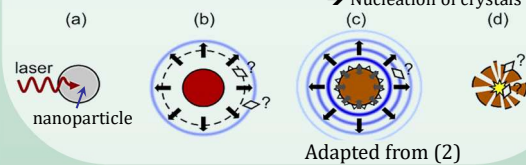
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NPLIN = Non-Photochemical Laser Induced Nucleation

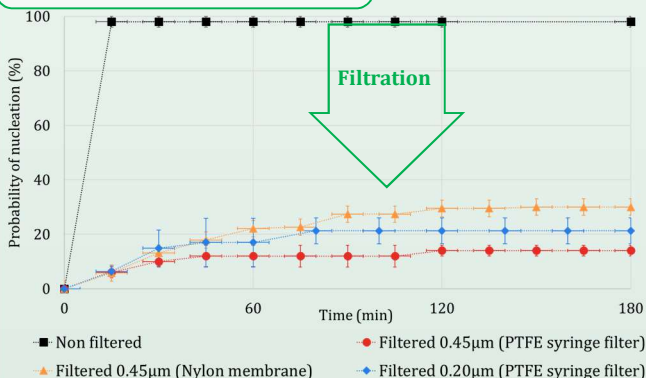
Nucleation process discovered by Garetz *et al*¹



How does it work?
Nanoparticle heating mechanism hypothesis

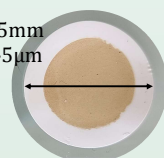


Influence of Filtration



→ Evidence of the **presence of impurities** in the initial solution : Impurities responsible for the NPLIN phenomenon

→ Analysis of the filter and characterization of the impurities
→ Orange solid impurities recovered from filtration
→ ICP-OES analysis results



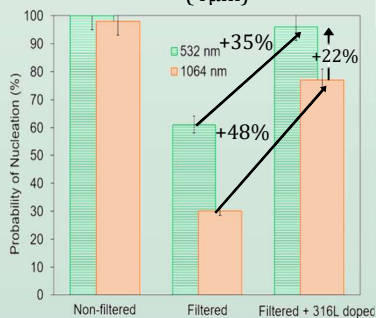
Concentration (mg/L)	Fe	Ni	Cr	S
Control	3.30	0.28	0.06	0.14
Impurity Sample	8.20	0.76	0.71	1.60

Metallic impurities → Possibly **Stainless steel**

Influence of Doping and Wavelength

Doping of EDS filtered solution ($\beta=1.10$) with small metallic particles, results at 200min after irradiation (1 ns pulse, 35mJ, wavelength : 1064 nm or 532 nm)

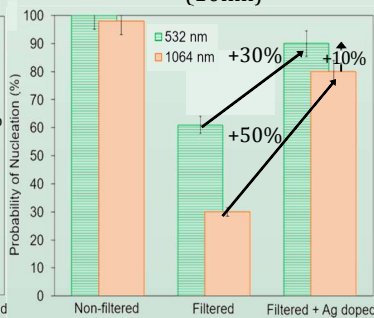
316L Stainless steel powder (4µm)



Gold Nanoparticles (10nm)



Silver Nanoparticles (10nm)



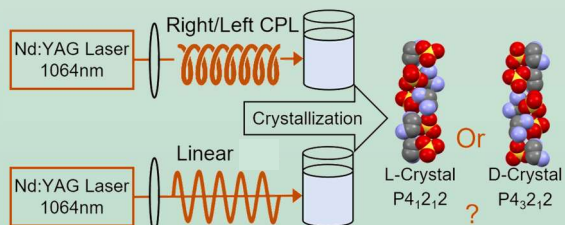
- **Solid metallic particles** in solutions required to retrieve high probability of nucleation with NPLIN
- Different behavior according to the nature of the doping particle
- **532nm** wavelength more efficient than **1064nm** (especially for gold that absorbs at 521nm)

Influence of Polarization geometry

Possible differences in particle absorption depending of the laser polarisation geometry

→ Different NPLIN responses expected

Experiment at $\beta=1.10$, 1pulse at 35mJ, 1064nm



EDS solution	Polarization	N _{vial}	N _{crystal}	N _D	N _L	Cee±σ
Unfiltered	L-CPL	89	194	99	95	0.02±0.07
	LP	91	249	127	122	0.02±0.06
Filtered	L-CPL	12	20	9	11	-0.10±0.20
	LP	12	15	7	8	-0.10±0.30

L-CPL : Left Circularly Polarized light ; LP : Linear Polarized light

Similar results when using 532nm wavelength

Use of polarized light to control EDS crystal chirality

→ The change in laser polarisation shows **no significant change** in the Crystal Enantiomeric Excess (Cee) or nucleation probability.

Conclusions

- Filtration decreases NPLIN efficiency
 - Doping increases NPLIN efficiency
 - NPLIN efficiency impacted by the wavelength of irradiation
 - No influence of laser polarization geometry on NPLIN
- In favor of the Nanoparticle heating mechanism

Perspectives

- Understand how particles are involved in the nucleation of the crystal to understand NPLIN mechanism
- Use of tailor made particle to trigger NPLIN in systems that are difficult to nucleate

