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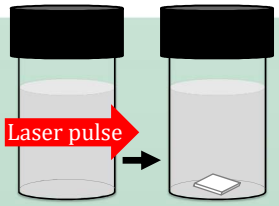
Influence of Filtration and Addition of Nanoparticles on the Non-Photochemical Laser Induced Nucleation Of Ethylene Diamine Sulfate

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Context

NPLIN stands for Non-Photochemical Laser Induced Nucleation.

- Nucleation process discovered in 1996 by Garetz *et al* (1)
- Laser pulses trigger nucleation from supersaturated solution



How does it works ?

Hypothesis of mechanism ➔ "Nanoparticle heating"

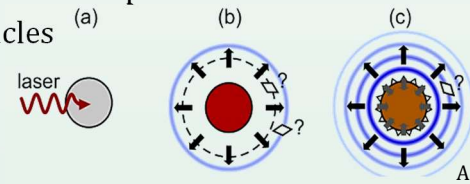
Observation : Filtration decreases or suppresses NPLIN due to insoluble particles in solution (2)(3)

(a) Absorption/diffusion of the laser pulse by an impurity particles

(b) Heating causes formation of vapor cavity => nucleation

(c) Collapse of the cavity causes pressure waves => nucleation

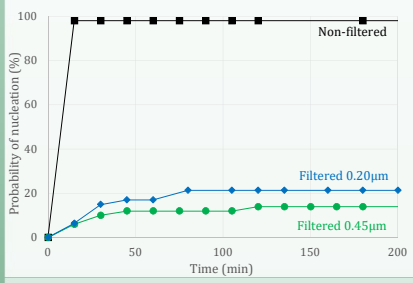
(d) Destruction of the particle



Adapted from (4)

Filtration & analysis of impurities

Preliminary test : NPLIN
Use of PTFE syringe filter
Pore size 0.20 and 0.45 µm

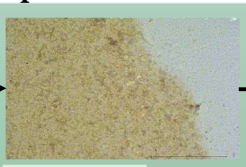


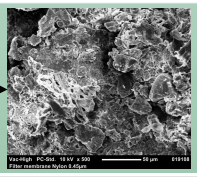
⇀ Size of impurities **>0.45 µm**

Use of Filter membrane for analysis



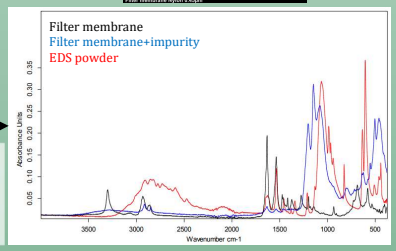
Microscopy → SEM





XRD → Amorphous solid

ATR-FTIR



Concentration → Insoluble impurities : 0.1 mg/g EDS

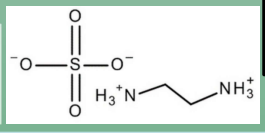
ICP

Concentration (mg/L)	Fe	Ni	Cr	S
Control	3.3	0.28	0.06	0.14
Impurity Sample	8.2	0.76	0.71	1.6

Metallic composition ➔ Stainless steel

Ethylenediamine sulfate (EDS)

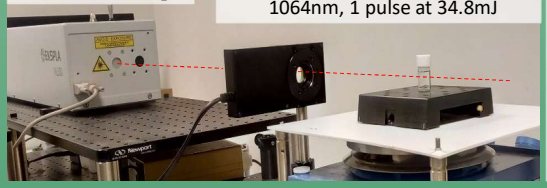
- 99% Purity
- Solution β = 1.10



NPLIN in Doped solutions

NPLIN set-up

Laser irradiation : 1064nm, 1 pulse at 34.8mJ



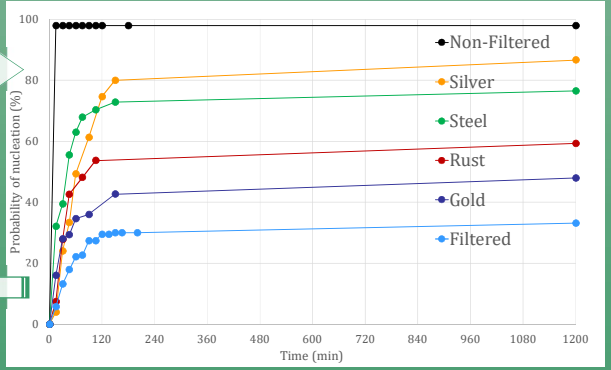
Addition of Nanoparticles in Supersaturated filtered solution

Silver nanoparticle (10nm)

Gold nanoparticle (10nm)

Stainless steel 316L

Rust from 316L steel



The kinetic behavior of NPLIN differs for the four particles tested

➔ Different **absorption/ diffusion** properties of the tested particles

There is no total recovery of the initial (non-filtered) behavior, maybe due to difference in composition, concentration, dispersion of the particles.

Conclusion & Perspectives

- Filtration **decreases the probability of nucleation** and **increases the induction time** in EDS solution
- Filtration removes **insoluble solid impurities**, that could came from industrial production => stainless steel rust ?
- The initial behavior can be partially retrieved by intentional addition of particles in the solution.

PERSPECTIVES : Possibility for compounds that do not exhibit NPLIN to nucleate by addition of particles.

References

(1)Garetz, B. A.; Aber, J. E.; Goddard, N. L.; Young, R. G.; Myerson, A. S. *Physical review letters* 1996, *77* (16), 3475.
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