Room Temperature FePt nanoparticles Formation Kinetics by Laser solution photolysis

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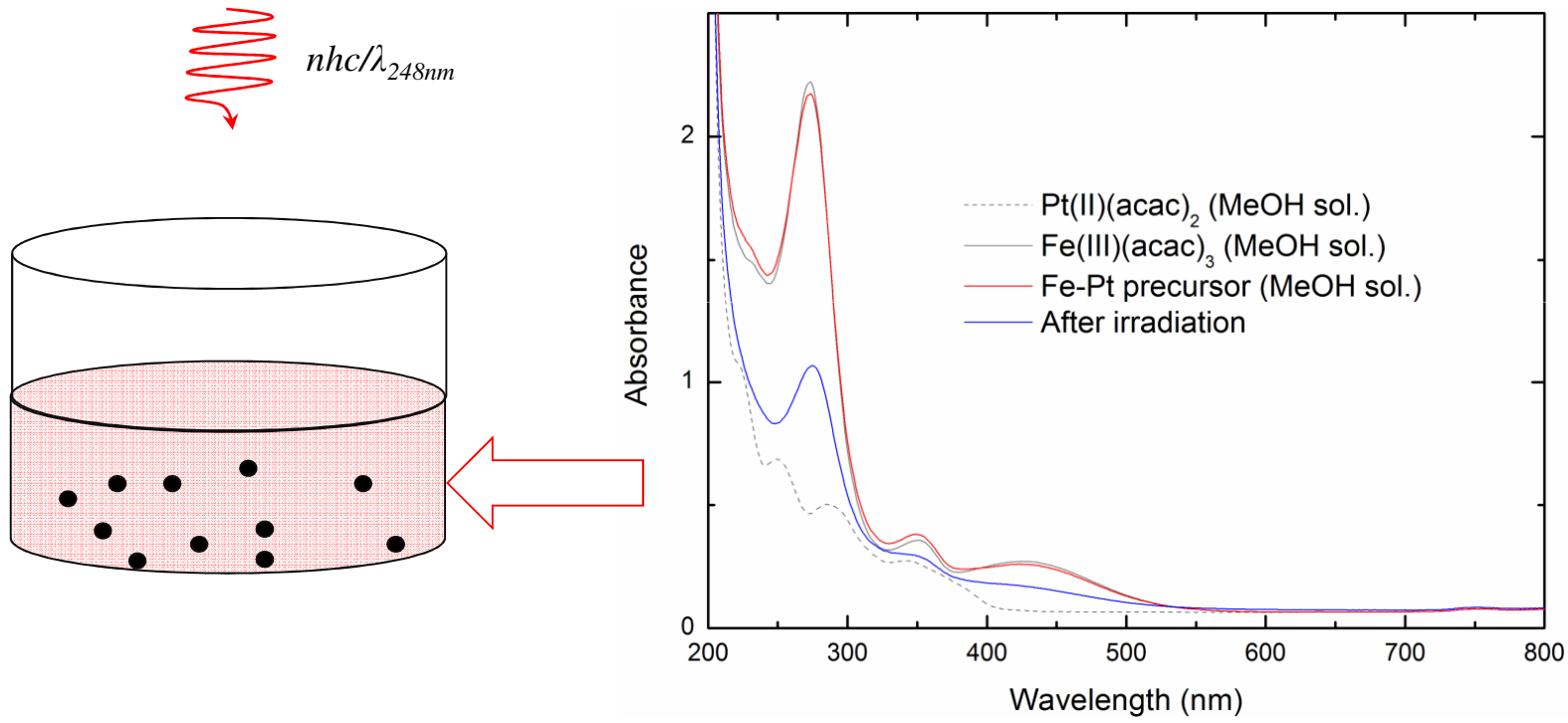
The 4th International Conference on Nanoscience and Nanotechnology
1 – 4 April 2012, University of the Free State, Bloemfontein

Content

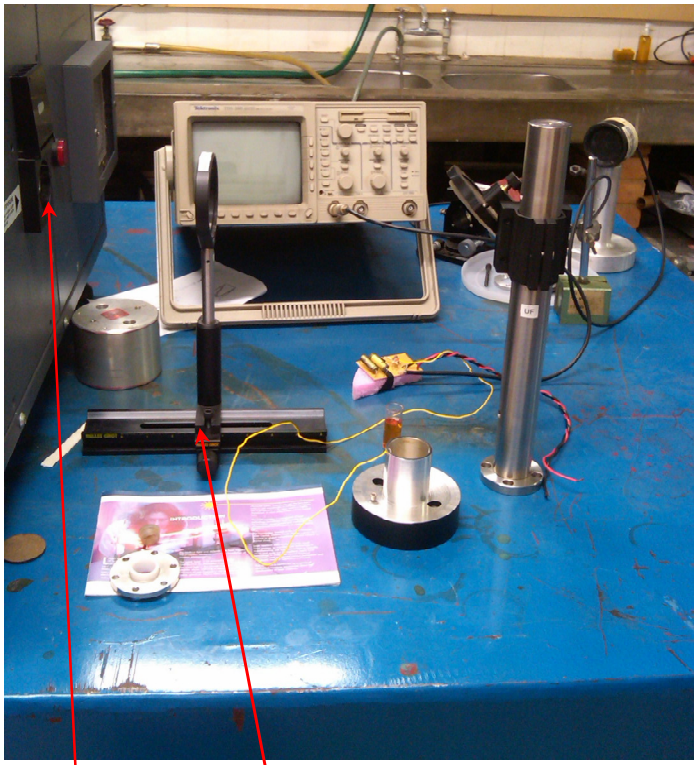
- Laser solution photolysis technique (introduction)
- New ways of measuring things
- Experimental set up
- Results and analysis

Laser solution photolysis



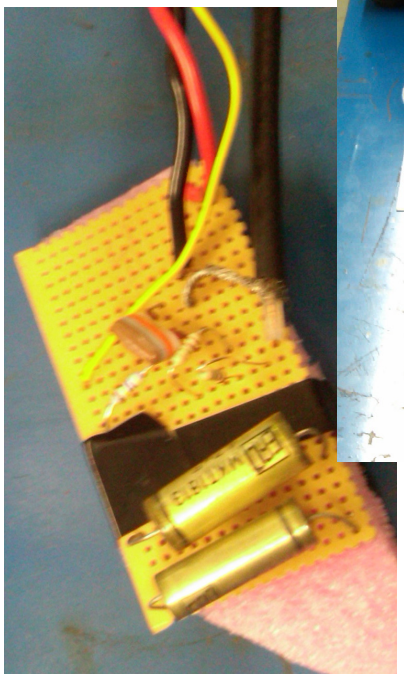
interaction between laser beam and liquid solution

Home built set – up

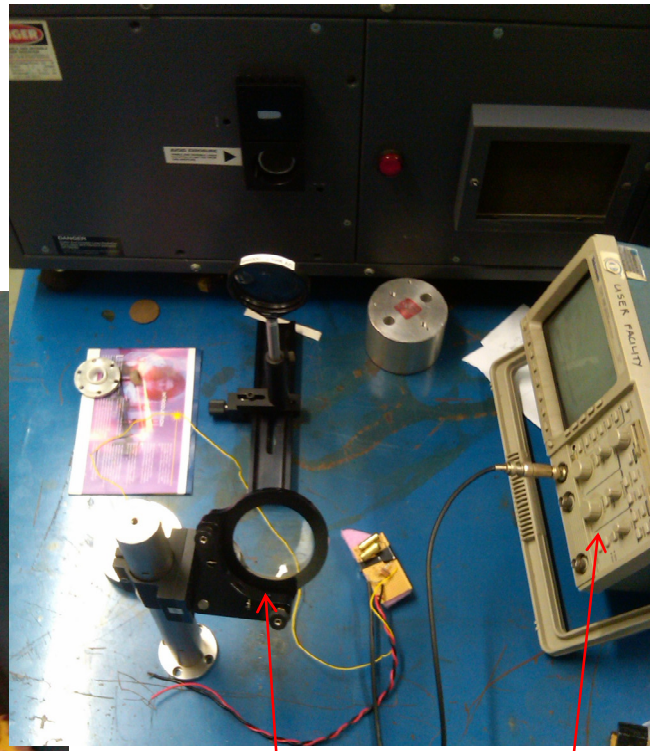


Pulsed Laser beam

Foc



Collecting circuit



BS

OSC

To date,

- many publication on materials processed by this technique

- most of the reports have presented on the nano-products of laser photolysis

- we design an experiment to measure;

✓ the radiation emission during photolysis,
✓ the produced either positive or negative metallic ions (liquid form).

Theoretical consideration

- $I_{LASER} = I_{refl} + I_{abs} + I_{trans}$ ⇦ Energy conservation (Kirchoff's law)

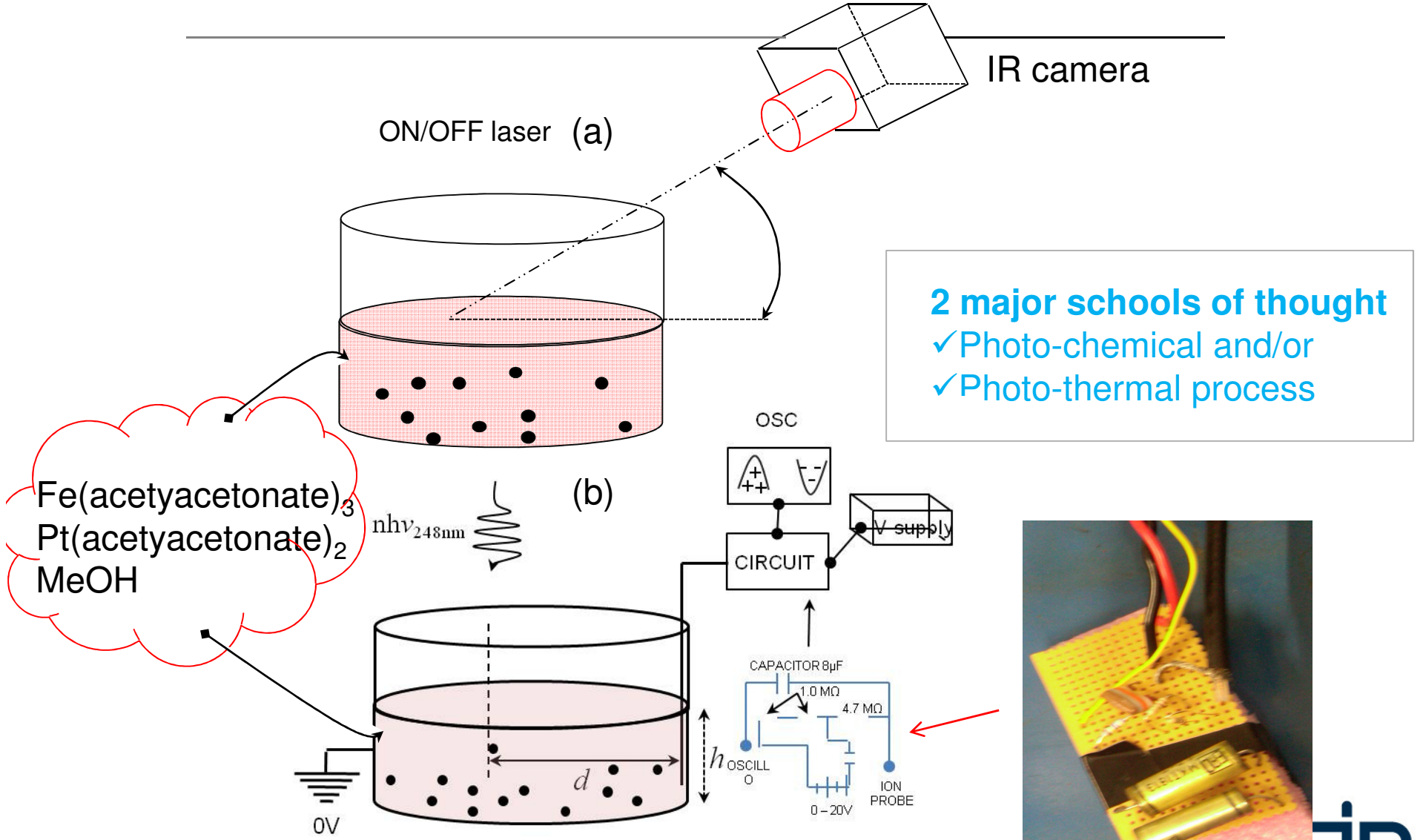
  - $I_{abs} = I_{trans} = C_p \frac{N}{V} \Delta V \frac{dT}{dt} + \Delta H \Delta V \frac{dN}{dt} + heat\_transfer\_losses$

  - $I_{refl} = c_{speed} \frac{P_{laser}}{(1+r)}$

⇩

$$\therefore I_{LASER} = c_{speed} \frac{P_{laser}}{(1+r)} + 2C_p \frac{N}{V} \Delta V \frac{dT}{dt} + 2\Delta H \Delta V \frac{dN}{dt} + 2\sigma A\left(T^4 - T_s^4\right) + 2\kappa_{conv} A\left(T - T_s\right)$$

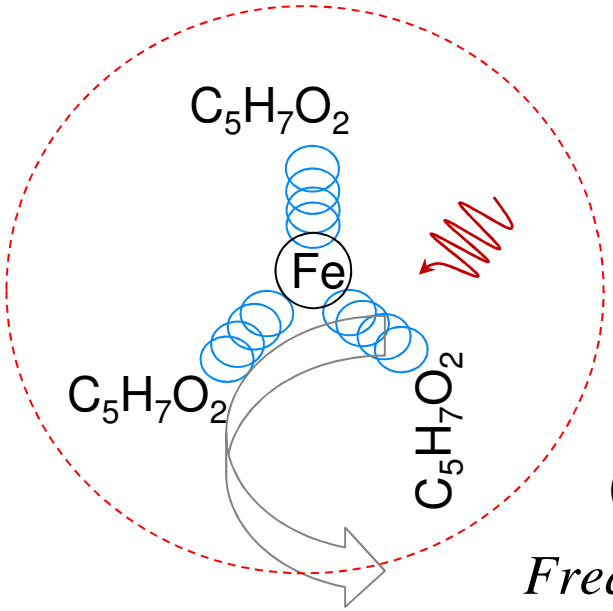
LSP experimental set-up



2 major schools of thought

- ✓Photo-chemical and/or
- ✓Photo-thermal process

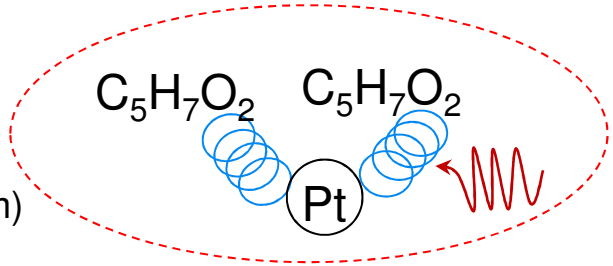
Ion time-of-flight



Fe — O

uv - frequency

LASER (248 nm)



(Resonance bond dissociation)

$$Frequency_{(Fe-O)/(Pt-O)} \approx Frequency_{(LASER)}$$

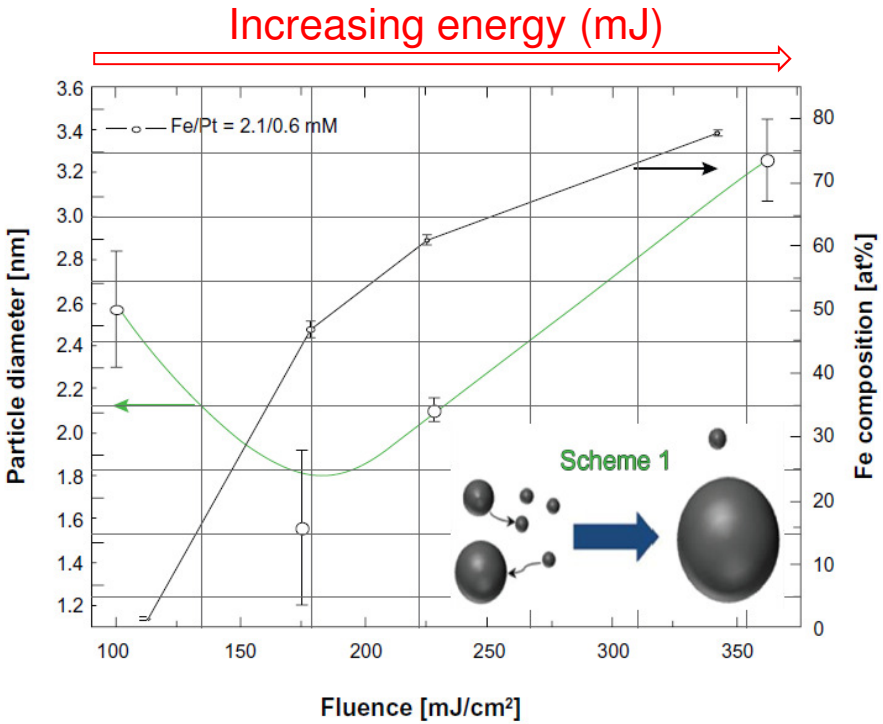
$$t_{ION} = \frac{d}{\sqrt{2U}}\sqrt{\frac{m}{q}}$$ ⇨ (vaccum)

$$t_{ION} = \frac{d}{\sqrt{2(U - V_{Collision})}}\sqrt{\frac{m}{q}}$$ ⇨ (many collisions)

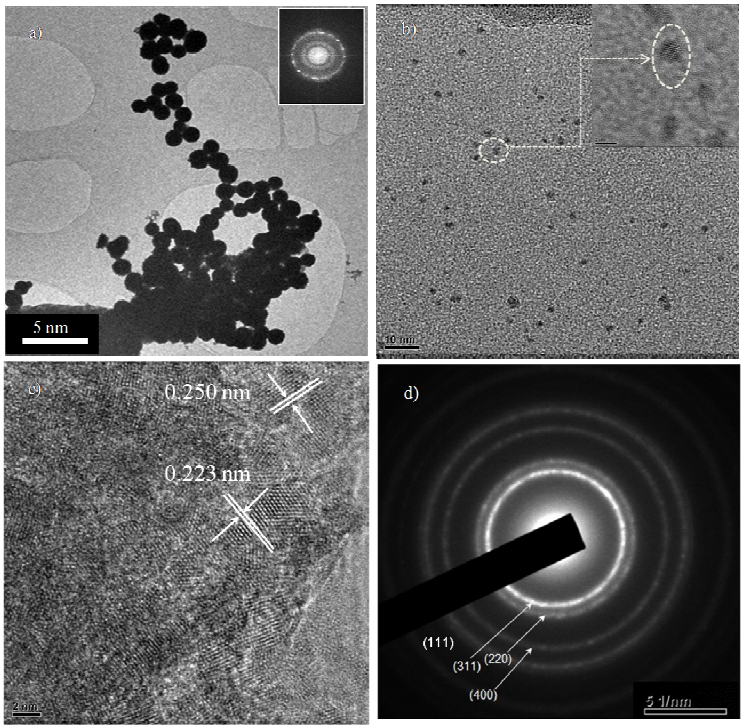
Multi-photon dissociation process

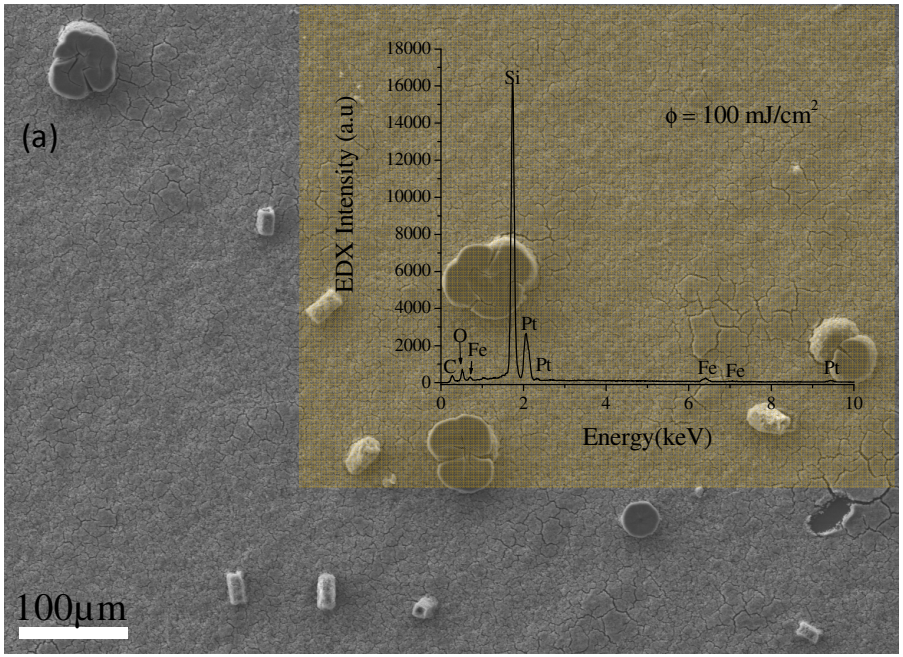
$$Fe(acac)_3 \xrightarrow{248\,nm} n(Fe) + photoproducts$$

$$Fe(acac)_3 + Pt(acac)_2 \xrightarrow{248\,nm} n(FePt) + photoproducts$$

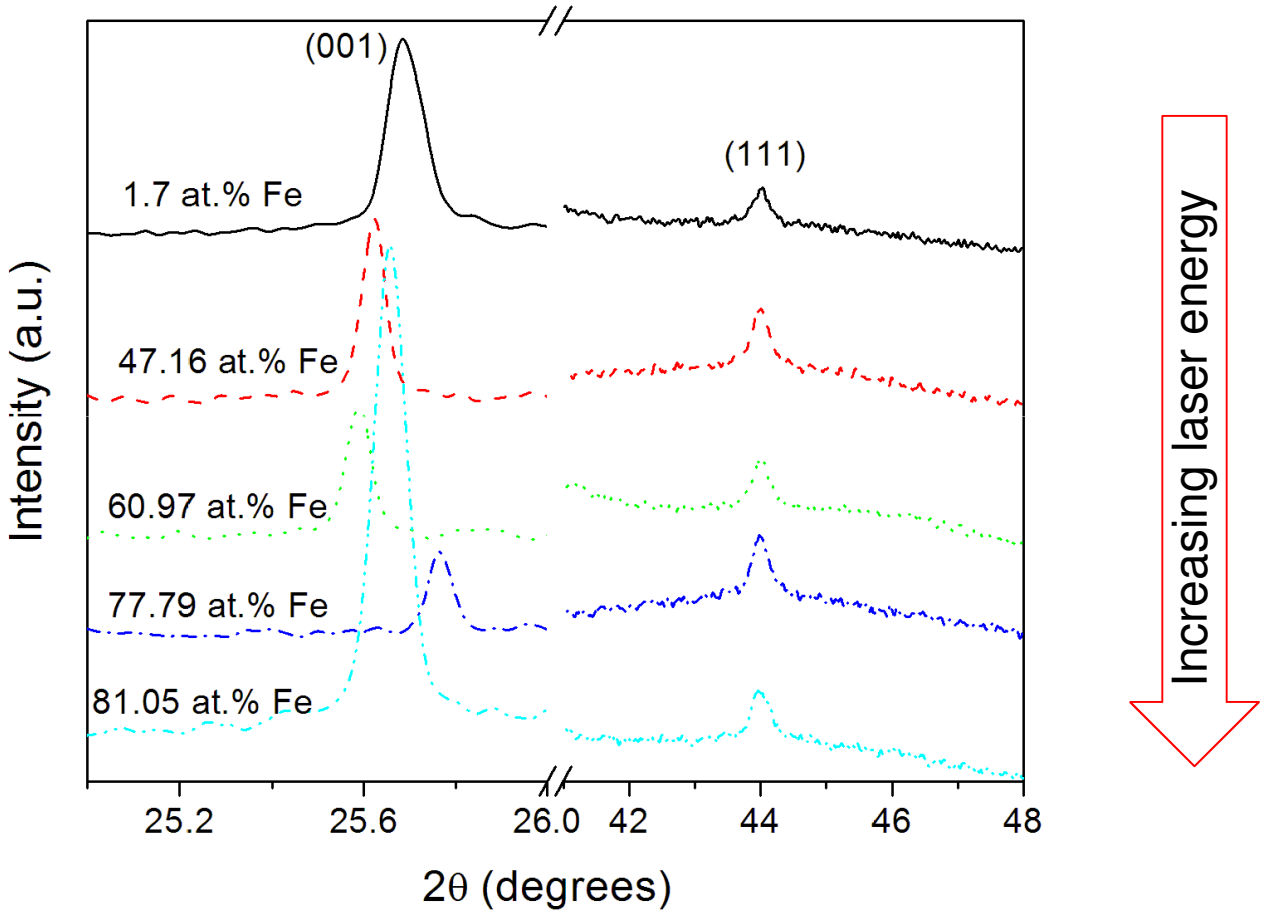


Structure and morphology





FePt alloying confirmation



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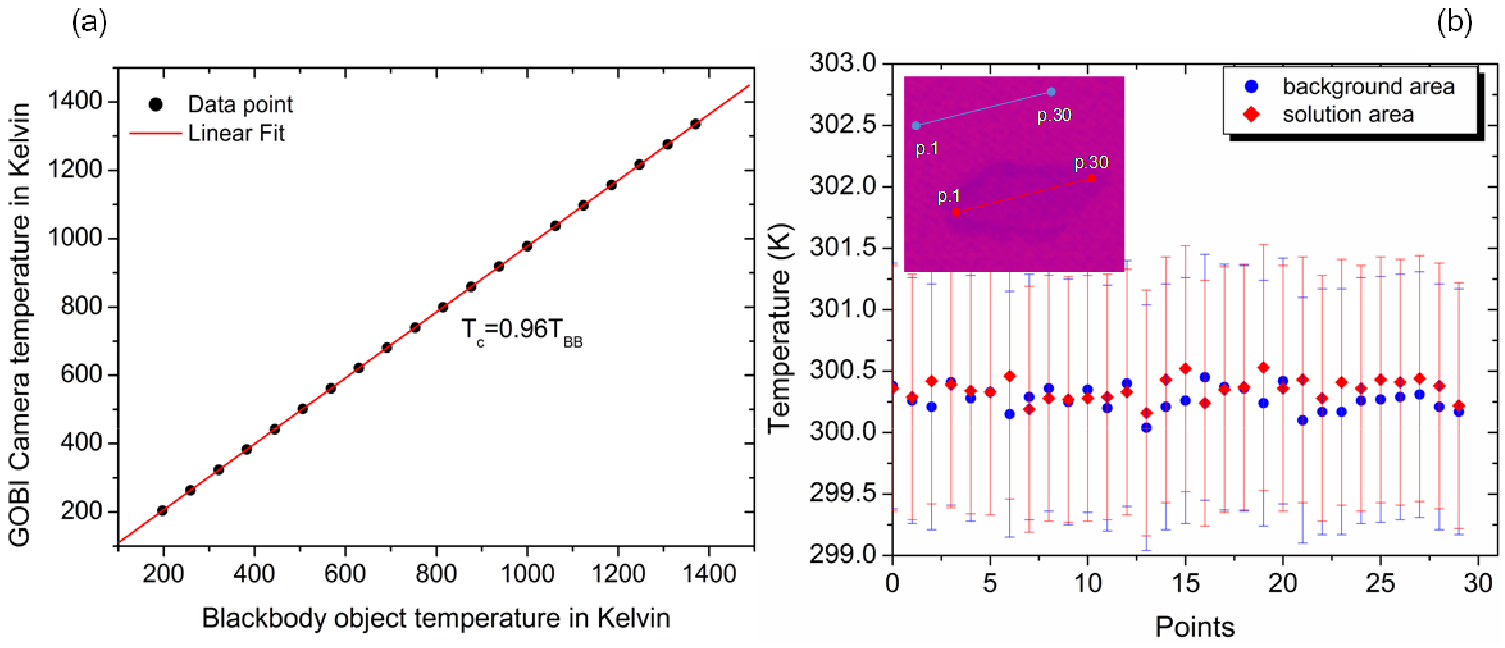
Temperature measurement



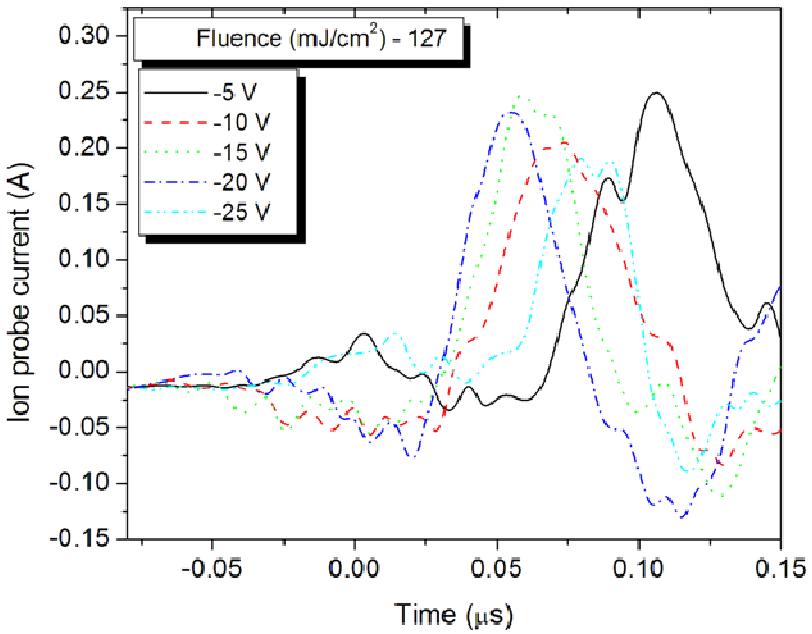
$$I_{Laser} = c_{speed}\frac{P_{laser}}{(1+r)} + 2C_p\Delta V\frac{dT}{dt} + 2\Delta H\Delta V\frac{dN}{dt} + 2\sigma A\left(T^4 - T_s^4\right) + 2\kappa_{conv}A\left(T - T_s\right)$$

$$I_{laser} = c_{speed}\frac{P_{laser}}{(1+r)} + 2\Delta V\Delta H_{Enthalpy}\frac{dN}{dt}$$

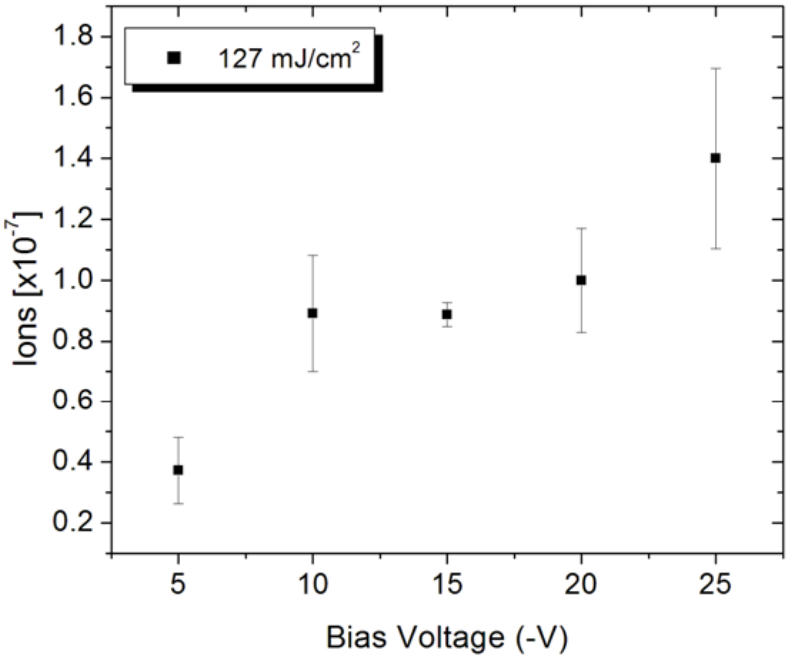
$$\frac{dN}{dt} = \frac{1}{e}\cdot\frac{dq}{dt}$$

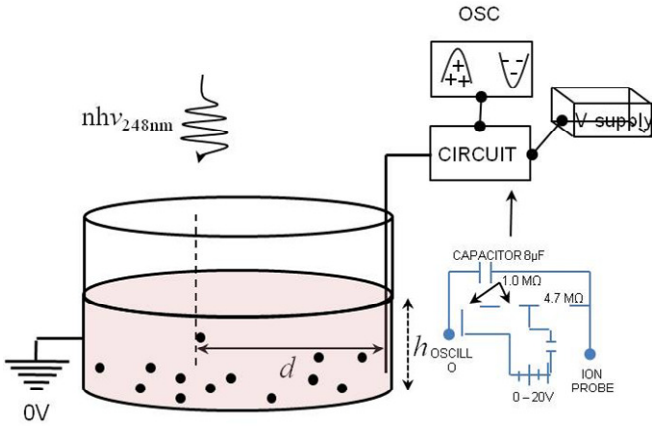
Ions time-of-flight measurements

(a)



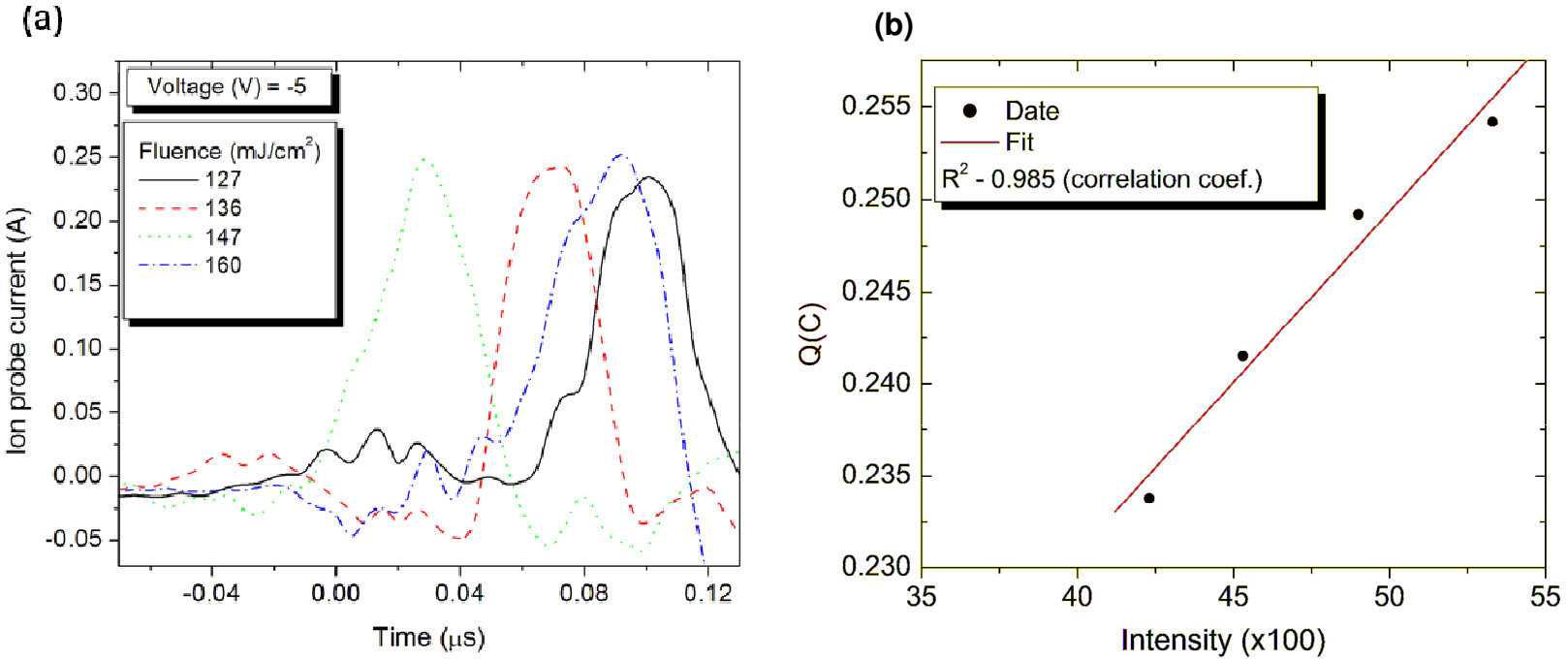
(b)



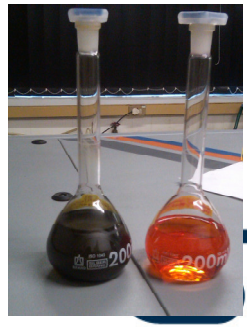


$$t_{ION} = \frac{d}{\sqrt{2(U - V_{Collision})}}\sqrt{\frac{m}{q}}$$

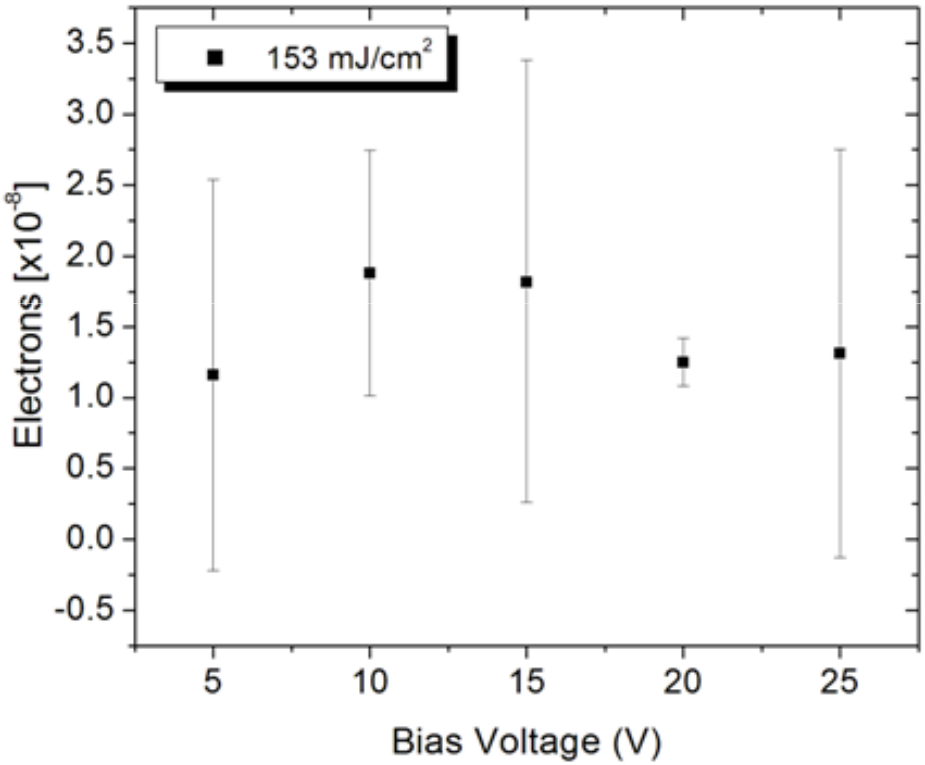
Positive ion data + fit



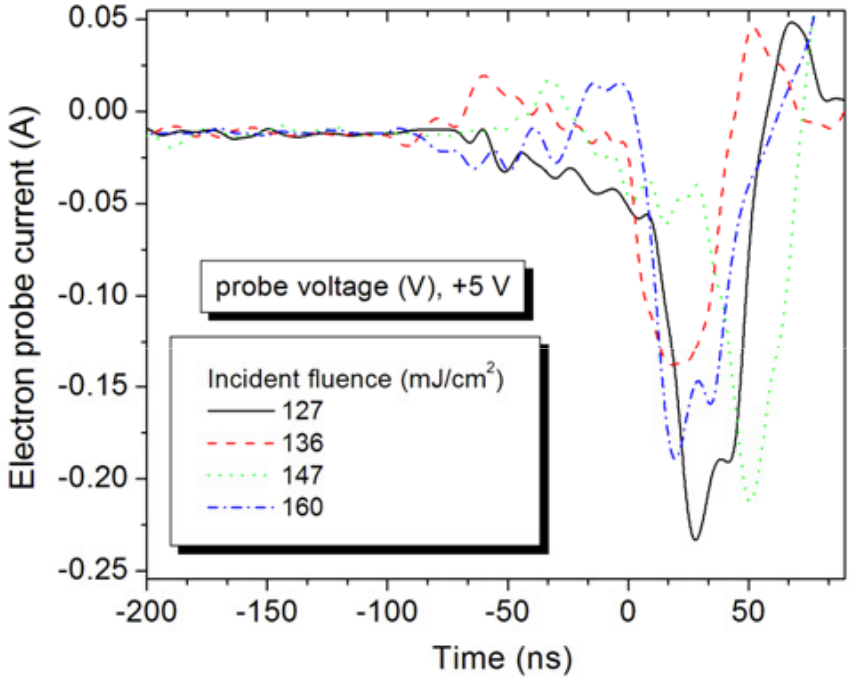
	ΔH(·10^{-6} J.mol^{-1})	Energy (·10^{-12} J)	Initial species,
	Enthalpy of dissociation	Background light	dq/dt
Positive ions	9.0061 ±	1.6238 ± 0.1113	0.15671 ± 0.0107

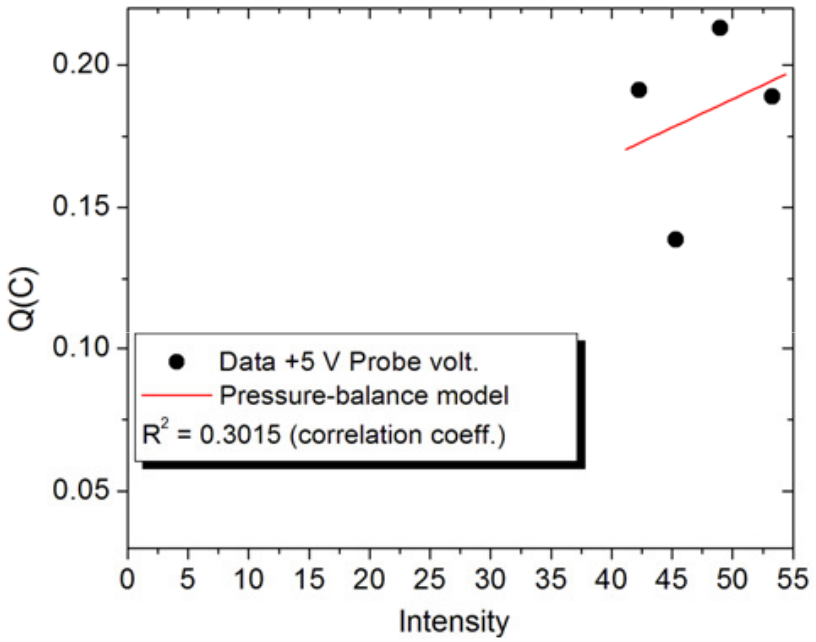


Electron probe



Electron data + fit





	ΔH(·10⁻⁶ J.mol⁻¹)	Energy (·10⁻¹² J.mol⁻¹)	Initial species, dq/dt
Electrons	8.3751 ±	0.8500 ±	0.08828 ±

Summary

- FePt Nanoparticles were successfully synthesized.
- Photo – Chemical process dominates over photo – thermal process.
- Electrons or negative ions could not be measured.
- Positive ions were measured with precision and however, positive ion could tell us more about the material than their counter-part.

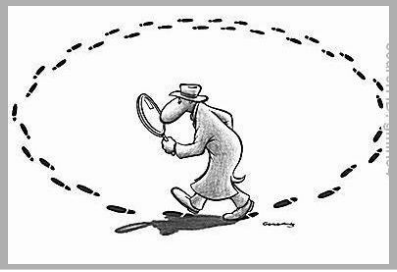
Thank You

Acknowledgements

National laser centre (NLC)

Henk Van Wyk (NLC)

Nico Marome (NLC)



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