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In-Situ determination of anticancer potential induced by Nickel Ferrite nanoparticles, against MCF-7 cancerous cells, using Atomic Force Microscopy under physiological conditions

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KEYWORDS

AFM, NPs, magnetic nanoparticles, anticancer, MCF-7 cancer cells, Near Field Microscopy.

SHORT SUMMARY

We report the use of an innovative experimental bench, based on Atomic Force Microscopy under physiological conditions, for the study of the anticancer activity of Nickel Ferrite nanoparticles. Indeed, magnetic nanoparticles, can be synthesized using different methods (physical or chemical) with controllable sizes. The optimization of synthesis protocols, enabled their applications in diverse fields (notably biological application in environment, health, etc.). We synthesized Nickel Ferrite nanoparticles, using solvothermal and hydrothermal methods. Nanoparticles obtained presented a size of 10 nm and 50 nm respectively. We examined their interaction with human breast cancer cells, MCF-7 cancerous cells, using AFM in liquid. The promising results obtained, particularly the rugosity and Young's modulus measures, and the statistical analysis performed showed significant difference between control and cancerous cells incubated with NPs

EXTENDED ABSTRACT

Atomic Force microscopy is a power tool to get precious information about the nanoscale surface of biological cells and their interaction with various external agents. Previously limited to the characterization of samples studied in air atmosphere, this technique has recently been extended to the study of biological samples, in particular thanks to the improvement of experimental protocols [1] [2], allowing AFM imaging in liquid and obtaining topographic and mechanical information on biological samples inaccessible by classical techniques. We therefore used an innovative experimental bench for characterization of our biological samples in liquid by Atomic Force Microscopy.

We observed the effects of exposing human breast cancerous cells MCF-7 to Nickel Ferrite nanoparticles. Indeed, magnetic nanoparticles exhibit excellent electrical, magnetic and optical characteristics that provided many opportunities in biomedical applications [3], specially anticancer activity [4]. We synthesized, Nickel Ferrite NPs using solvothermal method [5] (NPs's size obtained : 10nm) and hydrothermal method (NP's size obtained : 50nm).

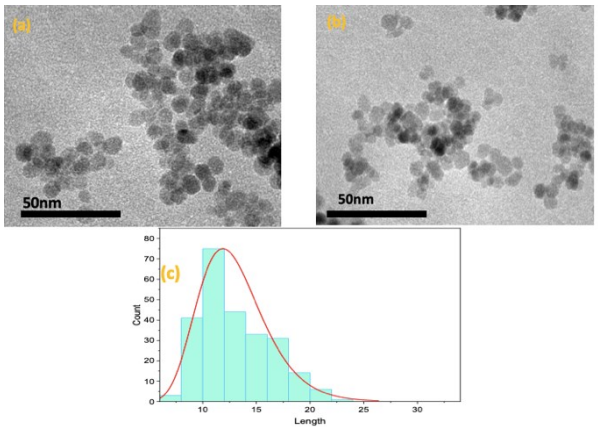

Figure 1. TEM images (a,b) of Nickel Ferrite Nanoparticles solvothermal synthesized (average size 10 nm).

First, we observed MCF-7 cancerous cells without NPs, as a control (figure 2).

Then, we tested the two types of nanoparticles on cells incubated for 12-14h prior measurements.

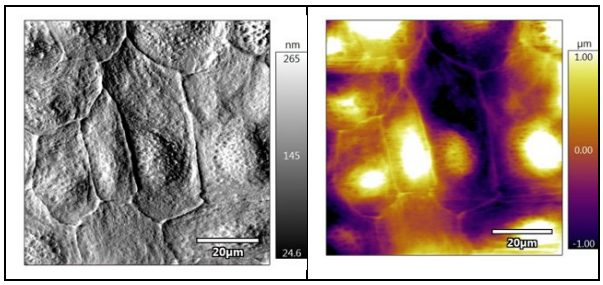

Figure 2. AFM height (right) and deflection (left) data of MCF-7 cancerous cells in liquid culture medium (control).

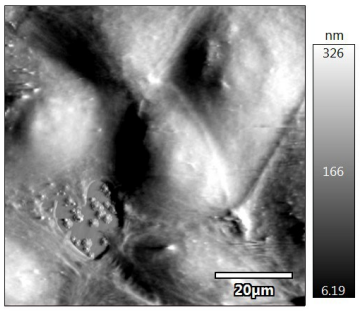

Figure 3. AFM height image of MCF-7 cancerous cells in liquid culture incubated with Nickel Ferrite nanoparticles.

AFM images of the cancerous cells exposed to the nanoparticles showed a significant difference with the control, in fact, the cells have clearly smaller size compared to the control cells (figure 4).

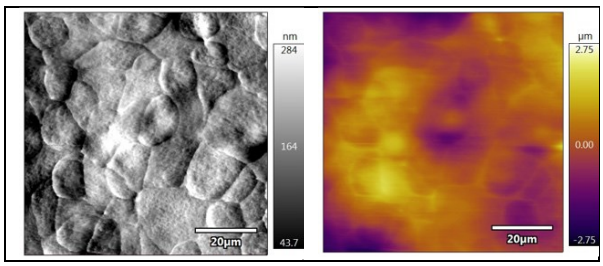

Figure 4. AFM height (right) and deflection (left) data of MCF-7 cancerous cells incubated incubated with Ferrite Nickel nanoparticles (50nm) in liquid culture medium.

Thanks to these AFM experiments, we not only have topographical data but also valuable data on the mechanical properties of the samples [1] [6]. Thereby, we measured the rugosity (RMS) and the Young's modulus (E). Rugosity (RMS) data showed significant difference between control and cells incubated with ferrite nickel nanoparticles (50nm, 250µg/mL). Young's modulus data showed a significant difference between control (figure 5) and the two types of ferrite nickel nanoparticles (10 and 50 nm) at two different concentrations 50 µg/mL and 500 µg/mL) (example , figure 6).

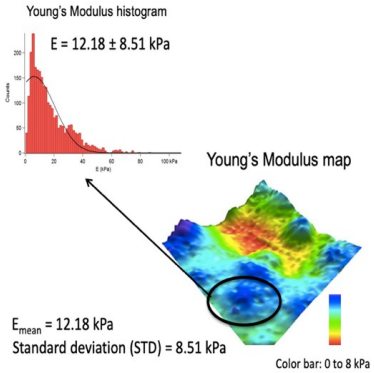

Figure 5. Young's modulus (E) measure using AFM in liquid medium on MCF7 cancerous cells (control), young's modulus 3D map (right) and histogram (left) are represented.

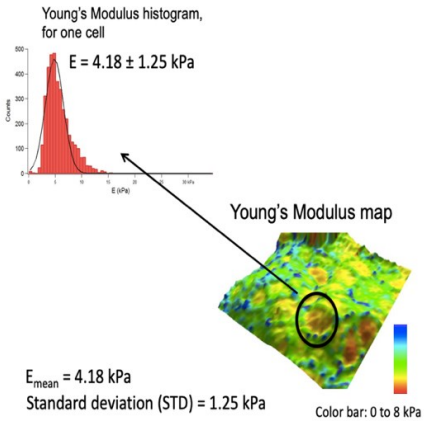

Figure 6. Young's modulus (E) measure using AFM in liquid medium on MCF7 cancerous cells incubated with ferrite nanoparticles, young's modulus 3D map (right) and histogram (left) are represented.

Our experiments enabled us to synthesize Nickel Ferrite nanoparticles and to explore their action on MCF7 cancerous cells using AFM in liquid.

Results obtained showed a significant difference between control and treated samples.

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