Magnetic nanodiamond for bio-imaging and cell manipulation
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Nanodiamond is one of the widely studied particles for bio-applications for its excellent physicochemical properties, biocompatibility, and ability to fluoresce without photobleaching which can be used for therapeutic and diagnostic purposes. With added magnetism, the magnetic nanodiamond (MND) can be manipulated with the external magnetic field. In this work, MND (Ray Technologies, Ltd.) has been characterized by Raman spectroscopy and SQUID measurement to determine crystal structure and character of its magnetism; imaging abilities of MND were estimated using two-photon Fluorescence Lifetime imaging (TP-FLIM). Low cytotoxicity was demonstrated against cancer A549 cells using MTT assay. Magnetic manipulation of the particle leading to enhanced cellular uptake and further control of cells distribution has been demonstrated. The MND can be used as a potential carrier for delivering the drug or other molecules to the affected sites using an external magnetic with tracking using fluorescence imaging.

Key words: nanodiamond bio-applications, magnetic nanoparticles, fluorescence lifetime imaging.

Influence of magnetic field on distribution of cell with MND

Fig.4. Distribution of the A549 cells incubated with MND and then re-cultured in MF using neodymium magnets (3 mm) and modified by magnetized wire (2) 50 µm. Measured in Laser scanning Fluorescence Microscope at 514nm excitation and emission around 600 to 700nm range

Magnetophoresis of MND

Fig.7. The light absorbance of the MNPs solution was measured every 10 minutes using a UV-vis spectrophotometer to infer the MND concentration in a homogeneously dispersed solution (a) schematics (b) Fixed wavelength absorption spectra at 400 nm

Distribution of MND in A549 Cells

Fig.5. Shows the distribution of 50µg/ml of MND in A549 cells measured in Laser scanning Fluorescence Microscope at 514nm excitation and emission around 600 to 700nm range

Two-Photon Fluorescence Lifetime Imaging

Fig.6. Cellular uptake of 10µg/ml MND in A549 cells (a) schematics, (b) & (c) without & with magnetic field which shows the influence of magnetic field (d) Lifetime decay curve of A549 and MND with well distinguishable lifetime

Conclusion

- MND exhibits strong magnetic susceptibility.
- No cytotoxicity of MND was observed using MTT assay.
- The labelling of cells with MND allows demonstration of magnetic guidance.
- Using external magnetic increased concentration of MND around the cells and enhanced cellular uptake can be seen.
- The labelling of cells with MND reveals possibility to use this ND like imaging marker for 2-photon lifetime imaging.
- It suggests high potential of MND for controlled drug delivery, cells manipulation and filtration, etc.