Optical Detected Magnetic Resonance and fluorescent Nanodiamonds: towards molecular resolution neuronal imaging

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Outline

- Neurons as RC circuits
- Background and motivations
- Why NV-NDs?
- Bare VS functionalized NV-NDs
- Experimental
- Future plans
Neurons: a tale of circuits and Action Potentials
Background and motivations

Nanoscale tools for monitoring cellular electrical activity

Drawbacks of Voltage/Calcium-Sensitive Dyes

Intrinsic limitations of existing techniques (Electrophysiology, MEG, EEG)

Non-invasive access to subthreshold synaptic events

Direct evaluation of local neural electromagnetic field

Temporal resolution combined with localization of sources of neuronal activity
Why Nitrogen Vacancy-NanoDiamonds?

Voltage Sensitive Dyes versus NV-NDs:

GemOnly electrical potential changes versus electric and magnetic fields measurements

High-resolution measurements of membrane potentials
Characterization and functionalization of NV-NDs

Electronic, chemical and morphological properties:
- SEM, TEM, DLS, Z-Potential, XPS, Raman, FTIR

Avoiding clustering:
- albumin
- lipid micelle embedding

Promoting internalization:
- cell-penetrating peptides
Interfacing NV-NDs with primary neuronal cultures/organotypic brain slices
Immuno-staining

Neurons

NV-NDs

Nuclei
Observing differences in NV-NDs photoluminescence in living neurons
Work in progress
NV-NDs localization and Patch Clamp recordings

Internalization:
- Fluorescence Microscopy, TEM
- Synchrotron Light: NEXAFS & Cryo-Electron Tomography

Effects on neuronal electrical activity and morphology
Correlating difference in NV-NDs photoluminescence with neuronal spontaneous activity
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