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## Multinuclear MR and MRI Study of Lithium-Ion Cells Using a Variable Field Magnet and a Fixed Frequency RF Probe

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An exploratory multinuclear MR and MRI study was performed on lithium-ion battery cells with  $^7\text{Li}$ ,  $^{19}\text{F}$ , and  $^1\text{H}$  measurements. A variable field superconducting magnet with a fixed frequency parallel-plate RF probe was employed in the study. The magnet's magnetic field was changed to set the resonance frequency of each nucleus to the fixed RF probe frequency of 33.7 MHz. Two cartridge-like lithium-ion cells, with graphite anodes and  $\text{LiNi}_{0.5}\text{Mn}_{0.3}\text{Co}_{0.2}\text{O}_2$  (NMC) cathodes, were interrogated. One cell was pristine and one was charged to a cell voltage of 4.2 V. The results presented demonstrate the great potential of the variable field magnet approach in multinuclear measurement of lithium-ion batteries. These methods open the door for developing faster and simpler methods for detecting, quantifying, and interpreting MR and MRI data from lithium-ion batteries.

### Keyword-1

Multinuclear MR/MRI

### Keyword-2

Lithium-ion Batteries

### Keyword-3

Variable field Magnet

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