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NQR/NMR and Mössbauer spectroscopy of sulfides: Potential and versatility

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Abstract

Nuclear quadrupole resonance (NQR), nuclear magnetic resonance (NMR) and nuclear gamma-resonance (NGR or Mössbauer Effect) methods are generally described as highly sensitive tools in studies of local electronic structure and symmetry in solid-state materials. This is due to high informativity in electronic structure investigations, high resolution in phase-structural diagnostics (down to nano-scale), possibility to study polycrystalline and complex compounds, and to the non-destructive character of these methods. As applied to Earth sciences, both NQR/NMR and Mössbauer spectroscopy methods contribute to mineralogical material science and mineral physics. Another important aspect is the fact that these methods, as demonstrated recently, belong to unique techniques suitable for on-line bulk mineralogical analysis. This includes remotely operated sensors used with conveyor systems in mining/materials handling and similar applications where real-time data collection/processing provides significant commercial benefits. These developments open new pathways for NQR/NMR and Mössbauer spectroscopy applications. Notably, NQR/NMR and Mössbauer effects are observed primarily on different nuclei-probes but provide similar information about the local properties of materials (hyperfine fields, electric field gradients and relaxation effects). This makes NQR/NMR and Mössbauer methods mutually complementary despite their significant technical differences. This paper includes examples of recent applications of NQR, NMR and Mössbauer spectroscopic tools to studies of copper-, antimony- and iron-containing sulfides, demonstrating how these methods can contribute to an improved understanding of geochemical problems.

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Keywords

Materials science, Mineral physics, Mössbauer effect, NMR, NQR, Sulfide