



	<b>Experiment title:</b> Missing Fe <sup>2+</sup> in microbial synthesis of nanoparticles	<b>Experiment number:</b> HC/2443
<b>Beamline:</b> ID18	<b>Date of experiment:</b> from: 20/07/2016 to: 26/07/2016	<b>Date of report:</b> 27/10/2016
<b>Shifts:17</b>	<b>Local contact(s): Chumakov Aleksandr</b>	<i>Received at ESRF:</i>
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## Report:

The nuclear inelastic scattering (NIS) measurements of control samples and samples obtained in an extracellular reduction of amorphous Fe(III)-hydroxide (AFH) by anaerobic bacterium *Geoalkalibacter ferrihydriticus* (strain Z-0531) [1] with different AFH and anthraquinone-2,6-disulfonate concentrations were performed at 7/8 mode of storage ring operation at room temperature (295 K) with the energy resolution of about 0.55 meV. Phonon spectra were measured for 9 samples. Number of scans depends on the sample and on the average was about 13. We performed additional scans for some samples (NC2, NC5 with different content of ferrous atoms) to get better statistics. Time spectra of the nuclear forward scattering were measured to initially observe the difference in particle size and Fe<sup>2+</sup> content in the samples.

Density of phonon states (DOS) was fitted from energy spectra [2]. Since the experimental samples were a mixture of several phases, the phonon spectra of reference phases were measured. Figure 1 shows DOS of siderite (red line), bulk magnetite (green line), synthesized magnetite (blue line), synthesized ferrihydrite (black line). Figure 2 shows reduced DOS of these minerals. Figure 3 shows DOS of experimental samples obtained during the bacterial growth. The graphs are arranged in Fe<sup>2+</sup> concentration increasing (from the lowest concentration in NC5 to the biggest NC3). It is well seen that DOS spectra are different for these samples. Energy NIS spectra treatment was performed by SpectrRelax [3] using three reference spectra. The relative concentration of Fe<sup>2+</sup> atoms obtained from NIS spectra presented in table 1 are in a good agreement with this concentration obtained by chemical methods.

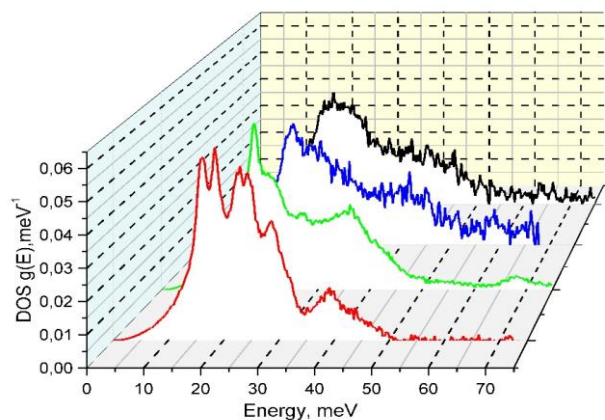


Figure 1. The derived density of vibrational states (DOS)  $g(E)$  of reference samples.

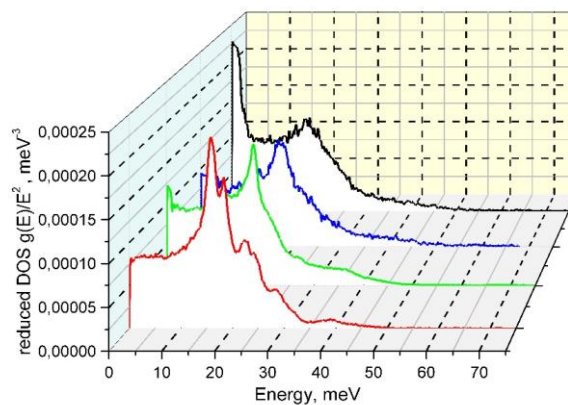


Figure 2. Reduced DOS  $g(E)/E^2$  of reference samples.

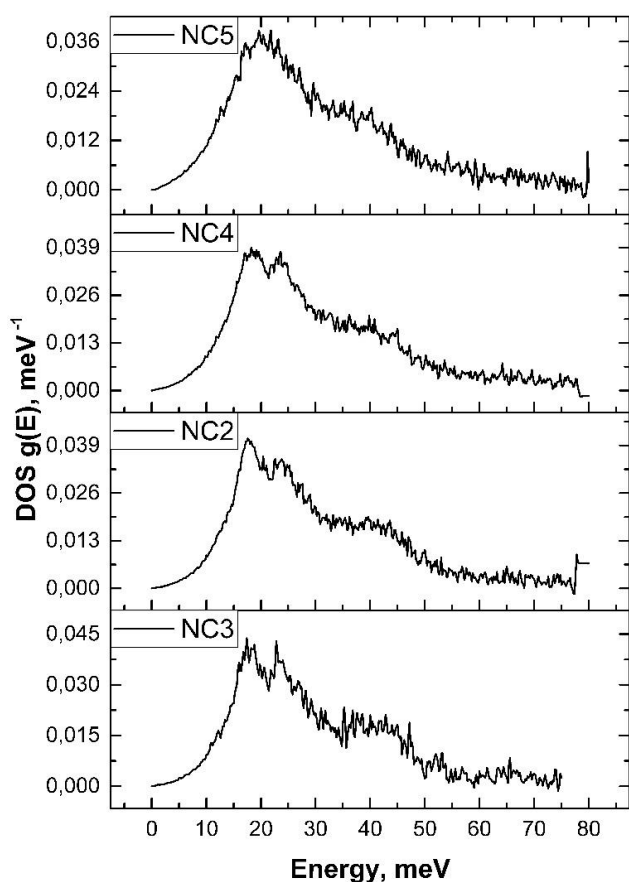


Figure 3. The derived density of vibrational states (DOS)  $g(E)$  of experimental samples obtained during the bacterial growth.

#### References

1. Zavarzina D G, Kolganova T V, Boulygina E S, Kostrikina N A, Tourova T P and Zavarzin G A, **Microbiology** **75**, 673 (2006).
2. Chumakov A.I., Sturhahn W., **Hyperfine Interactions** **123/124**, 781-808 (1999).
3. Matsnev M.E., Rusakov V.S. **AIP Conf. Proc.** **1489**, 178-185 (2012).

Table 1. The relative contents of siderite, ferrihydrite and magnetite in the experimental samples.

Sample	Relative Content, %			Relative concentration, %
	Siderite	Ferrihydrite	Magnetite	$\sum Fe^{2+}$
NC3	32.2±3.1	41±5	27±4	~ 41
NC2	33.2±2.1	41±4	26±3	~ 41.1
NC4	14.6±1.5	70.3±2.4	15.2±2.1	~ 19.6
NC5		80.3±2.2	19.7±2.2	~ 6.6