SUPPORTING INFORMATION

Adsorption of water, methanol and formic acid on Fe_2NiP, a meteoritic mineral analogue

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Detailed experimental methodology

Ultrahigh vacuum experimental setup

The chamber is equipped with a turbomolecular pump (Pfeiffer TPU 170) backed by a rotary–vane mechanical pump (Oerlikon Leybold NT16), a rotary–vane mechanical pump (Oerlikon Leybold NT5) connected to the custom gas manifold, two convectron gauges that read a minimum pressure of 1×10^{-4} torr (Granville–Phillips 275), an ionization gauge that reads a minimum pressure of 3×10^{-11} torr (nude Bayard–Alpert hot cathode), a quadrupole mass spectrometer (Hiden HALO 201–RC), a Fourier transform infrared spectrometer (Nicolet 6700), and an electron gun with tunable energies from 5 to 2000 eV (Kimball Physics ELG–2). Solid samples, either iron–nickel phosphide or an iron–nickel alloy, were attached to a sample manipulator that rotated 360^{o} via a differentially pumped rotational stage (McAllister DPRF 275), and that stage was pumped by a rotary–vane mechanical pump (Edwards RV12 HP). Surface temperatures ranging from approximately 100 to 680 K were achieved using N_2 (l)

cooling and radiative heating. A tantalum plate was spot–welded to the back of the sample to improve the cooling by increasing thermal contact between the copper extension of the N_2 (l) dewar and the solid samples (i.e., Fe_2NiP or FeNi). Tungsten wires with a diameter of 0.01" were connected to the tantalum in order to radiatively heat the sample. Temperatures were measured by a type–K thermocouple that was spot–welded to the surface of the sample.

Flattening and polishing procedure of the iron-nickel phosphide (Fe_2NiP) sample

To flatten the sample, the sample was first smoothed with 60-grit sandpaper and then with 120-grit sandpaper on a roll grinder (Buehler HandiMet 2). The sample was further flattened with 180-grit sandpaper using a grinder-polisher (Buehler EcoMet 300). The grinder-polisher was set at 250 rpm and the sample was pressed against the sand paper with a pressure of 5 psi for 2 minutes. This step was repeated using 320-grit sandpaper. To polish the sample to a mirror finish, a 9 μm diamond suspension was sprayed onto an ultrapad cloth and the sample was pressed against the cloth for 5 minutes at 5 psi with the grinder-polisher set at 150 rpm. This step was repeated with 3 μm and 1 μm diamond suspension sprayed on trident cloth, followed by a 0.05 μm alumina suspension sprayed on microcloth.

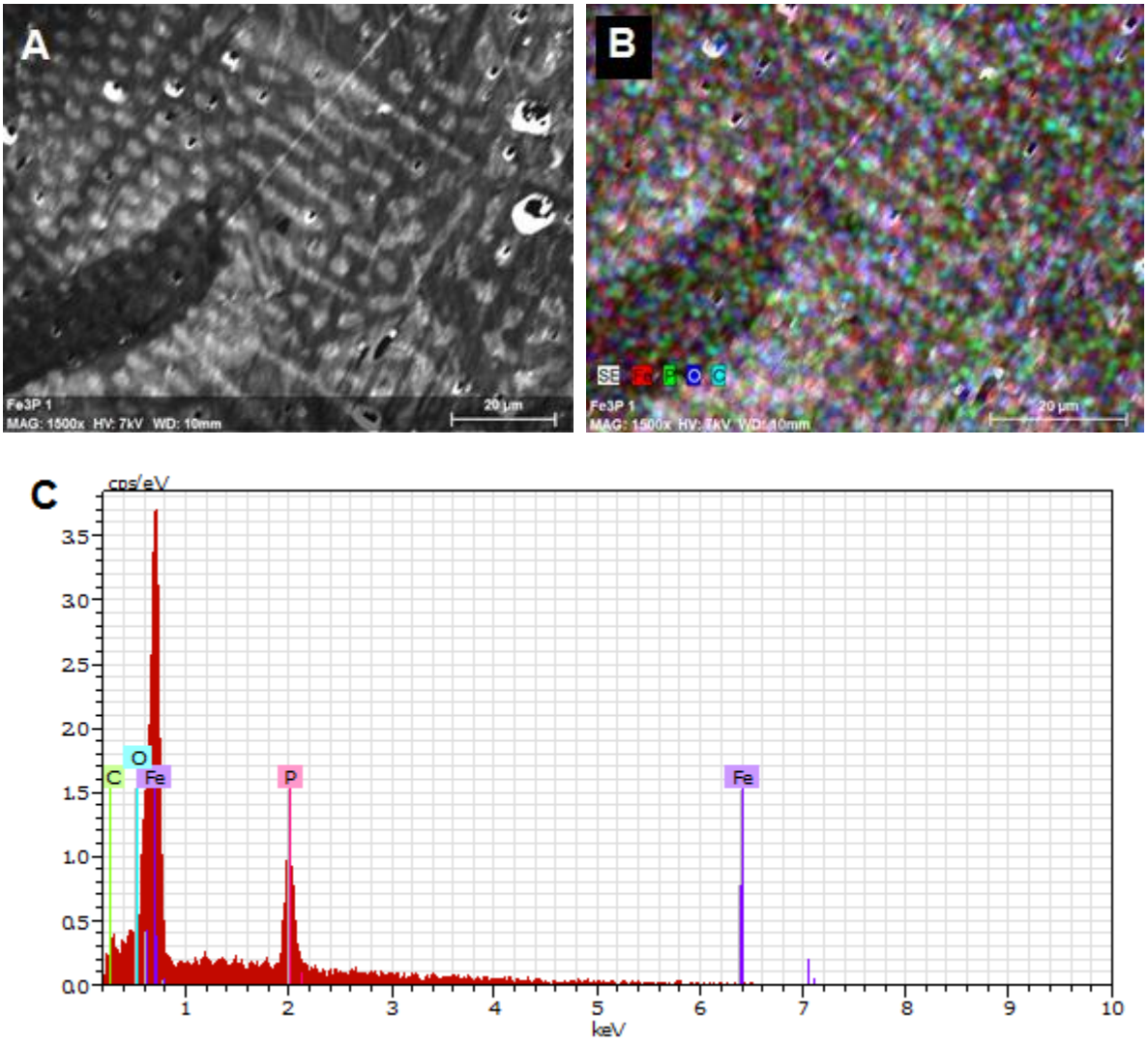

Figure S1. (a) Secondary electron image of a synthetic Fe_3P surface, (b) the SEM image in A is overlaid with an elemental map of iron (red), phosphorus (green), oxygen (blue), and carbon (cyan), and (c) the elemental composition shows the relative abundance of each element. Data was obtained using an SEM/EDX instrument at Kennesaw State University (GenTech Scientific, JEOL JSM-5800).

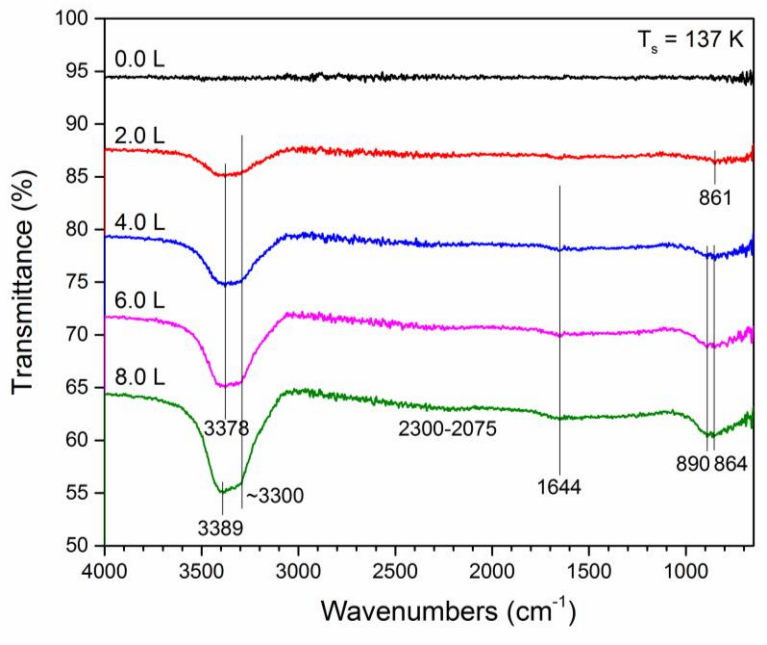

Figure S2. RAIRS spectra of H_2O adsorbed to FeNi control sample with dosages of 2.0 L – 8.0 L. Experiments were performed with a sample temperature of 137 K. Note that higher dosages of H_2O were needed on FeNi because the RAIRS signal intensity was lower than for the Fe_2NiP sample presented in Figure 4.

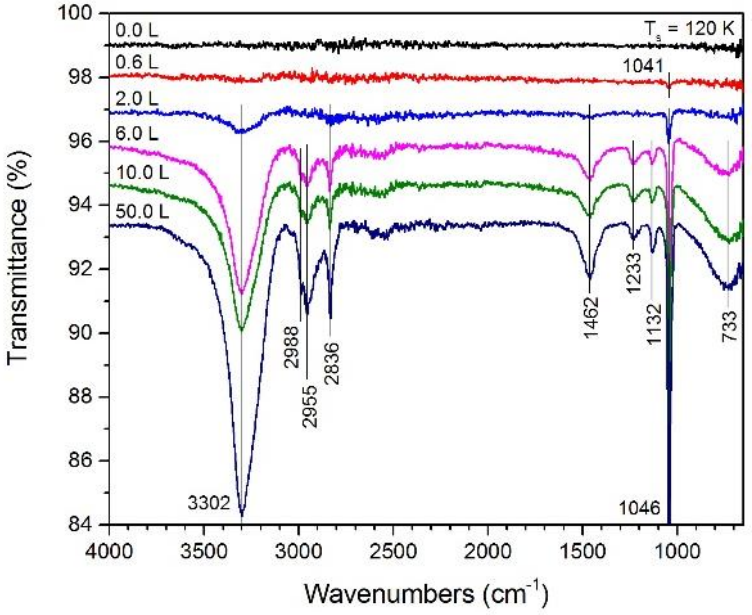

Figure S3. RAIRS spectra of CH_3OH adsorbed to Fe_2NiP with dosages of 0.6 L – 50.0 L. Experiments were performed with a sample temperature of 120 K.

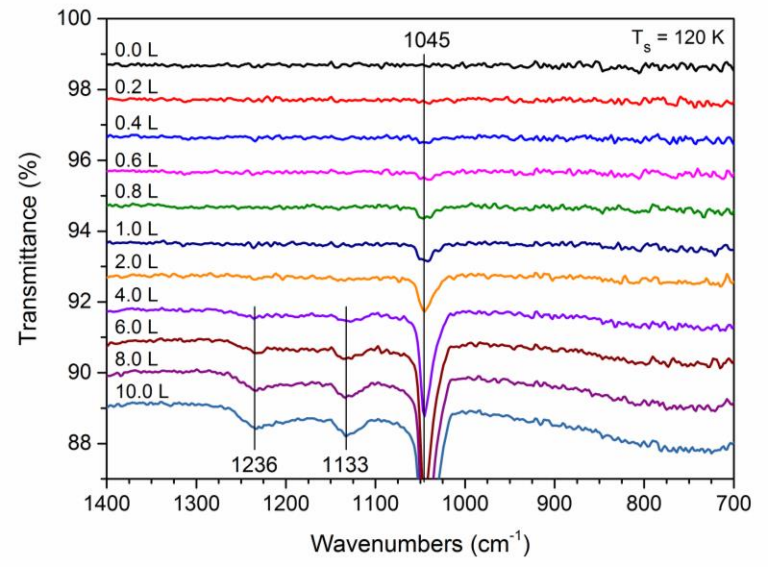

Figure S4. RAIRS spectra of CH_3OH adsorbed to Fe_2NiP with dosages of 0.2 L – 10.0 L in the C-O stretch region. Experiments were performed with a sample temperature of 120 K.

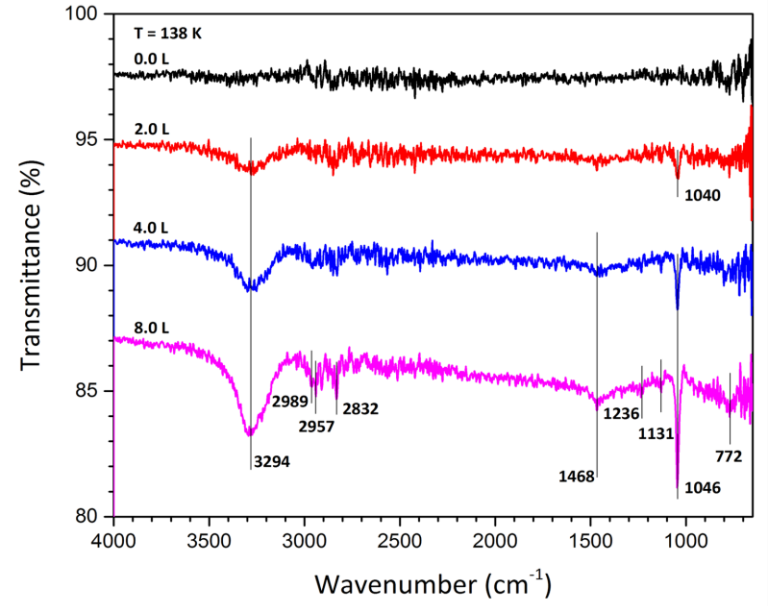

Figure S5. RAIRS spectra of CH_3OH adsorbed to FeNi with dosages of 2.0 L – 8.0 L Experiments were performed with a sample temperature of 138 K.

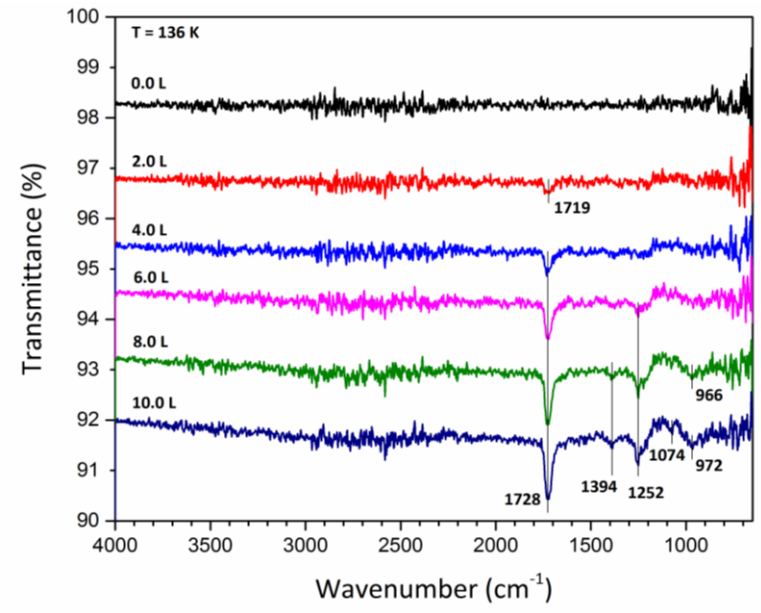

Figure S6. RAIRS spectra of HCOOH adsorbed to FeNi with dosages of 2.0 L – 10.0 L Experiments were run with a sample temperature of 136 K. Only the most intense formic acid peaks are observed in these spectra, suggesting that the alignment was better for the Fe_2NiP surface than for the FeNi surface.