OBSERVATION OF WATER AND ORGANICS IN CORBONACEOS CHONDTRITES IN 3D USING SCANNING-IMAGING X-RAY MICROSCOPY: DEVELOPMENT OF A NEW TECHNIQUE. A. Tsuchiyama[1], A. Takeuchi[2], K. Uesugi[2], Y. Suzuki[2], T, Nakano[3], A. Miyake[1], J. Matsuno[1] and M. E. Zolensky[4], [1]Graduate School of Science, Kyoto University, [2]JASRI/SPring-8, [3]AIST/GSJ, [4]NASA/JSC.

In order to search for fluid inclusions in carbonaceous chondrites, we have developed a nondestructive technique using X-ray absorption micro-tomography combined with FIB micro-sampling [1]. We found fluid inclusion candidates in micron-size in calcite grains, which were formed by aqueous alteration. However, we could not determine from the absorption contrast images whether they are really aqueous fluids or merely voids.

Phase and absorption contrast images can be simultaneously obtained in 3D by using a new technique named scanning-imaging x-ray microscopy (SIXM) [2]. The phase contrast may enable us to discriminate water from void. Organic materials may also be discriminated by this technique as well as some mineral identification. This technique has potential availability for Hayabusa-2 sample analysis.

In this study, we observed standard materials by SIXM to check quantitative phase and absorption contrasts and the spatial resolution. We also applied this technique to carbonaceous chondrite samples.

Complex refractive index can be expressed by $n=1-\delta+i\beta$, where the real part, $1-\delta$, is the refractive index with refractive index decrement, δ, which is nearly proportional to the density, and the imaginary part, β, is the extinction coefficient, which is related to the liner attenuation coefficient, μ. The phase and absorption contrast images in SIXM can be regarded as spatial distributions of δ and μ, respectively. As $\mu = 0.0$, 10.4 and 204.3 cm^{-1} at 8 keV for air, water and calcite, respectively, for example, it is hard to discriminate between air and water. In contrast, $\delta \times 10^6 = 0.00$, 3.62 and 8.88, respectively, which makes easy to discriminate between them. If we compare μ and δ in SIXM images, many phases can be identified.

We used POM ($[CH_2O]_n$), silicon, forsterite, corundum, magnetite and nickel as standard materials for μ and δ quantitative performance test. A fluid inclusion in terrestrial quartz and bivalve shells (Atrina vexillum), which are composed of calcite and organic layers with different thickness, were also used for the spatial resolution test. The Ivuna (CI), Sutter's Mill (CM) and Tagish Lake meteorites were also used as carbonaceous chondrite samples.

A rod- or cube-shaped sample (20-30 μm in size) was extracted mostly from a polished thin section, which was previously observed with SEM, by using FIB. Then, the sample was attached to a thin W-needle and imaged by an SIXM system at beamline BL47XU, SPring-8, Japan. The slice thickness was 109 nm and the pixel size was mostly 100 nm.

In preliminary results, we found almost linear relation between the μ and δ values obtained by SIXM and their theoretical values, respectively, with a proportional coefficient of ~0.9. We can identify an organic layer about 3 μm thick in the shell by its δ value but not about 300 nm thick. The results including carbonaceous chondrites will be given.

[1] Tsuchiyama et al. 2014, *MAPS*, 49: A404. [2] Takeuchi et al. 2013, *J. Synchrotron Rad.*, 20: 793.

SIMULTANEOUS IRON AND NICKEL ISOTOPE ANALYSES WITH CHILI. R. Trappitsch[1,2,*], T. Stephan[1,2], M. J. Pellin[1,2,3,4], M. R. Savina[1,5], and A. M. Davis[1,2,4], [1]Chicago Center for Cosmochemistry, [2]Department of the Geophysical Sciences, The University of Chicago, [3]Materials Science Division, Argonne National Laboratory, [4]Enrico Fermi Institute, The University of Chicago, [5]Physical and Life Sciences Division, Lawrence Livermore National Laboratory. *trappitsch@uchicago.edu

Introduction: The CHicago Instrument for Laser Ionization (CHILI) is a resonance ionization mass spectrometer designed to analyze trace element isotopic composition and elemental abundances with a lateral resolution of ~10 nm and a useful yield of ~40% [1]. CHILI uses six tunable Ti:sapphire lasers to resonantly ionize up to three elements simultaneously and avoid isobaric interferences. The goal of this study is to measure Fe and Ni isotopes in presolar grains that condensed in the vicinity of dying stars. These isotopes can be used as proxies for galactic chemical evolution for grains that formed around asymptotic giant branch stars. In grains originating from supernovae, Fe and Ni isotopes can be used to constrain the stellar nucleosynthesis.

Methods: We developed ionization schemes for Fe and Ni isotopes that use three photons each [2]. CHILI measures the sample at a repetition rate of 1 kHz. One shot consists of first desorbing material from the sample surface using a 351 nm desorption laser and electrostatically ejecting the prompt secondary ions. The ion optics are then brought to extraction potential, and, subsequently, the ionization lasers fire and resonantly ionize neutral Fe and Ni atoms above the sample surface. The photoions then travel through a time-of-flight (TOF) mass spectrometer and are detected with a microchannel plate. The start signal for the TOF measurement is given by the ionization laser pulse. Delaying the Ni ionization lasers by 200 ns relative to the Fe ionization lasers allows separation of ^{58}Fe from ^{58}Ni so that all nuclides of interest can be measured without isobaric interferences. The CHILI control software allows each shot to be recorded individually, which will help to correct for dead time effects resulting from variabilities in the laser desorption process. As done for atom probe tomography [3], we are exploring using correlated events from different isotopes in individual shots as a dead time correction method.

Results: We previously reported presolar grain data for Zr, Sr, and Ba measured with CHILI [4]. For Fe and Ni, we found that we fully saturate all laser transitions and that the isotopic ratios are stable. For standards, δ-values for all even-numbered isotopes are zero within uncertainty when comparing standards with isotopic ratios from the literature. Odd-numbered isotopes show the well-known odd-even effect from laser ionization. Uncertainties are a few ‰ (2σ).

Conclusion and Outlook: Presolar SiC grains will be measured for their Fe and Ni isotopic composition in the next few weeks. Within the next few months, we will also study Fe and Ni isotopic anomalies in hibonite grains that show ^{50}Ti anomalies and will constrain the initial ^{60}Fe abundance in chondrules. The capability to measure isotopic compositions of trace elements at high spatial resolution is furthermore critical for samples brought back from space by the Genesis, Hayabusa, and Stardust missions, as well as future samples from Hayabusa 2 and OSIRIS-REx.

References: [1] Stephan T. et al. 2014. *Lunar Planet. Sci.* 45: 2242. [2] Trappitsch R. et al. 2012. *Lunar Planet. Sci.* 43:2497. [3] Stephan T. et al. 2015. *Int. J. Mass Spectrom.* 379:46–51. [4] Stephan T. et al. 2015. *Lunar Planet. Sci.* 46:2825.