Direct observation of supercooled water in hardened Low Heat Portland Cement

K. Mori(A), Y. Inamura(B), O. Yamamuro(B), T. Fukunaga(A)
(A)Research Reactor Institute, Kyoto University, (B)ISSP, University of Tokyo

Frost damage on concrete buildings is one of the most serious problems in cold districts like Hokkaido in Japan. Freezing of water makes its own volume increase up to as much as 9%, inducing internal pressure within concrete materials. However, the freezing and thawing cycle of water is very complicated due to an existence of supercooled water below 273 K. In this work, we performed directly to observe the freezing and thawing water in hardened Low Heat Portland Cement (LHPC) by using the quasi-elastic neutron scattering (QENS) method.

The LHPC clinkers were hydrated with light water (H2O) at 301 K in air. The H2O to LHPC mass ratio is 0.5. After a couple of days, the hardened LHPC was soaked in water. QENS data of the hardened LHPC were measured at temperatures between 202 K and 302 K on the high-resolution pulsed cold neutron spectrometer, AGNES, installed at the ISSP at University of Tokyo. The energy resolution of the AGNES is 120 μ eV when the neutron wavelength is 4.22 angstrom.

Figure 1 (a), (b), (c) and (d) show QENS spectra at 302 K, 272 K, 262 K and 242 K. The closed and opened circles indicate the freezing and thawing processes, respectively. The solid line is the QENS spectrum at 202 K, corresponding to the energy resolution of the AGNES. This means that the water in the hardened LHPC freezes completely below 202 K. Above 242 K, the QENS was clearly observed, that is, the supercooled water exists at temperatures between 242 K and 273 K. Furthermore, it was found that the freezing and thawing cycle of water in the hardened LHPC has a little hysteresis below 273 K.

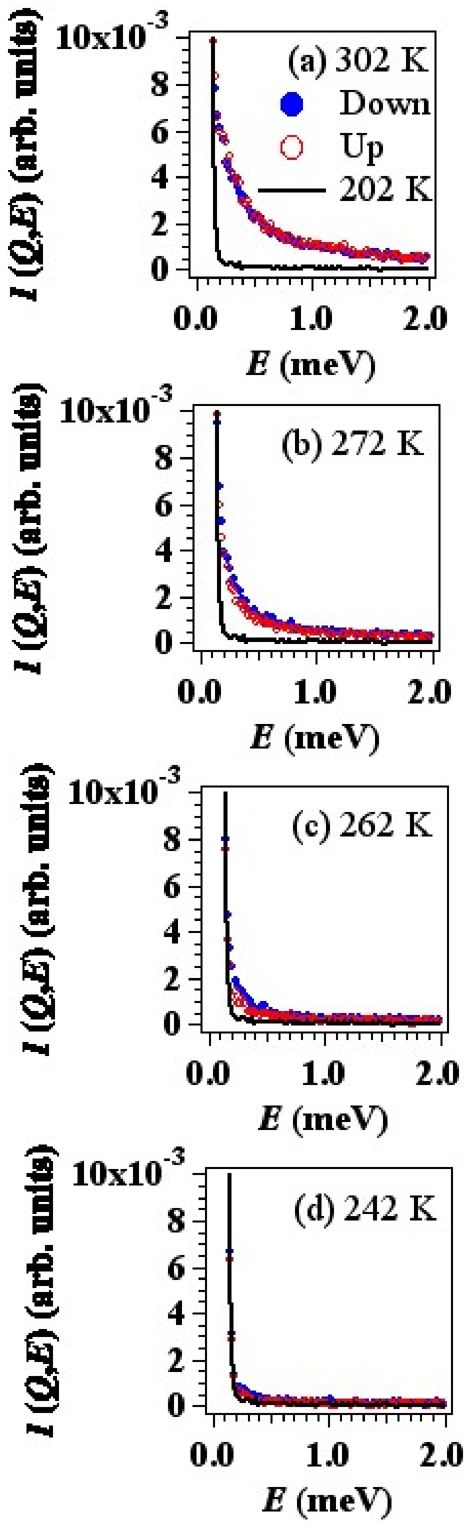

Fig. 1. QENS spectra at 302 K, 272 K, 262 K and 242 K.