Six types of decagonal quasicrystals (DQCs) and some crystalline approximants have been found in Al-Co-Ni alloys with a wide compositional range from 8 to 25.5 at.% Co and from 20 to 5 at.% Ni with a nearly constant Al content of around 70 at.%, and so the stability of the six DQCs is considered to depend on a ratio of Co/Ni associated with chemical ordering of Co and Ni. However, the study of the chemical ordering of Co and Ni in the Al-Co-Ni DQCs is difficult because of next atomic numbers of Co and Ni, though arrangements of transition-metal (TM) atoms have been determined by Cs-corrected HAADF-STEM observations [1-2]. Besides, it was impossible to distinguish between Co and Ni in a W-(AlNiCo) crystalline approximant by single-crystal X-ray diffraction [3]. Our intention in the present paper is two-fold; the first is to study the structure of the Al-Co-Ni crystalline approximant by Cs-corrected HAADF- and ABF-STEM observations, and the second is to investigate the chemical ordering of Co and Ni in the structure. Using a Cs-corrected scanning transmission electron microscope (JEM-ARM200F), HAADF and ABF images were simultaneously acquired with an incident beam parallel to the b-axis. And atomic-resolution elemental maps were taken with a newly developed silicon drift detector (SDD). The chemical ordering of Co and Ni is clearly seen in the acquired elemental maps. Co atoms are enriched in atomic columns with a decagonal section of 1.2 nm in diameter, and Ni atoms are located in gaps between two-dimensional arrangements of the 1.2 nm atom clusters. It can be concluded that the area ratio of the Co-rich 1.2 nm atom clusters to the Ni-rich gaps results in various types of Al-Co-Ni DQCs with different arrangements of the 1.2 nm clusters.


Keywords: Cs-corrected Scanning transmission electron microscopy, Energy Dispersive X-ray Spectroscopy, Al-Co-Ni Crystalline approximants