

MS19-O3 Space group of periodic cubic $\langle 110 \rangle$ six-way cylinder packing structures

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In the field of science, the complex structure of garnet has been explained on the basis of cylinder packing to be a periodic structure with a cubic $\langle 111 \rangle$ four-way cylinder packing [1]. Since then, cylinder packings have been extensively applied in the field of crystal chemistry. In particular, homogeneous cubic cylinder packings have been thoroughly investigated [2, 3]. In the field of engineering as well, cylinder packings are important for determining the fiber packings of composite materials [4, 5, 6]. The focus of our research is packing structure of equal cylinders having infinite length; specifically, the directions of these cylinders are restricted to six cubic $\langle 110 \rangle$ directions, namely, $A[1\ 1\ 0]$, $B[1\ -1\ 0]$, $C[1\ 0\ 1]$, $D[-1\ 0\ 1]$, $E[0\ 1\ 1]$, and $F[0\ 1\ -1]$. We refer to such a structure as a $\langle 110 \rangle$ six-way cylinder packing. There are several distinct $\langle 110 \rangle$ six-way cylinder packings [7, 8]. The known $\langle 110 \rangle$ six-way cylinder packings can be classified into three categories on the basis of packing density: $(\sqrt{2})\pi/9 \approx 0.494$ (Type-I), $(\sqrt{2})\pi/18 \approx 0.247$ (Type-II), and $(351\sqrt{2} + 108\sqrt{6})\pi/1936 \approx 0.376$ (Type-III). Recently, Teshima and Matsumoto studied the space group of the Type-III structure [9]. And Moore reported another type of periodic cubic $\langle 110 \rangle$ six-way cylinder packing structure (packing density ≈ 0.133) [10, 11]. In this study, authors will mention the space group of the Type-I and Type-II and consider a general description of periodic cubic $\langle 110 \rangle$ six-way cylinder packing structures.

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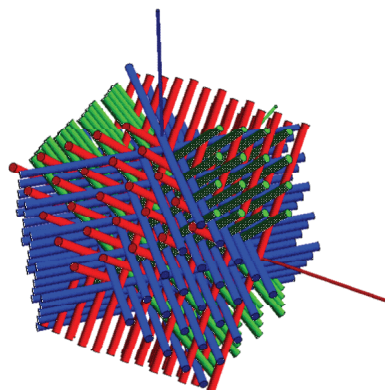


Figure 1. Overview of cylinder packing along six cubic $\langle 110 \rangle$ directions: Type-III

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