

Cylinder packing with five directions

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Packing problems are an important aspect of crystallography. In particular, sphere packings have played an important role in improving our understanding of crystal structures. Although cylinder packings have not received as much research attention as sphere packings, they are also important for the same reason and have been investigated in the fields of both science and engineering.

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 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.

In the field of engineering as well, cylinder packings are important for determining the fiber packings of composite materials [2]. Apart from cylinders, bars with various cross-sectional shapes are used in composite materials to enhance the packing density. Some regular fiber packing structures have been designed.

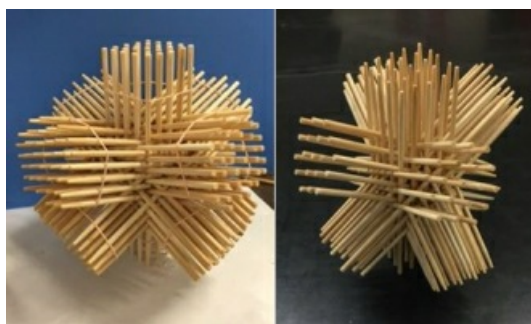
Motivated by structures of composite materials [2], periodic six-way cylinder packing structures have also been investigated [3].

In this study, authors will focus on two structures of cylinder packing with five directions. One of them was described in the pioneering paper[2]. Other one is new and should be distinguished from the former one. The two structures are derived from two distinct structures of cylinder packing with four directions.

[1] O' Keeffe, M. & Andersson, S. (1977). *Acta Cryst.*, A33, 914–923.

[2] Hijikata, A. & Fukuta, K. (1992). *Nihon Fukugoh Zairyou Gakkaishi (J. Japan Soc. Composite Materials)*, 18, 231–238 [in Japanese].

[3] Teshima, Y. & Matsumoto, T. (2012). *Glass Phys. Chem.*, 38-1, 41-48.



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