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Due to my major in materials science, I wish to pursue something that is related to materials. I am particularly intrigued by the optimization and study of materials through the use of the natural (or created) defects in their crystal structures.

According to studies by H. Khanbareh, J. H. Kruhl, and M. Nega, one type of these defects, grain boundaries—the intersections of two crystals (grains)—exists in fractal dimensions.[1] [2] Although grain boundaries are classified as 2-D defects, in aluminum alloys and in recrystallized quartz, their fractal dimensions lie between ~1.05 and ~1.30. [3] In quartz, the dimensional range can be used to predict the temperature of the recrystallization, while in aluminum the range can be used to predict the fracture toughness of the alloy.[4]

Khanbareh, Kruhl, and Nega all note that the fractal nature of the studied materials is related to the Koch curve (Koch snowflake), which repeats according to the following pattern:

1. Take an equilateral triangle.
2. Split the sides into three equal lengths.
3. On any "outward" facing side (a side that is not connected to a previous triangle), take the central length and create an equilateral triangle from it.
4. For each triangle in the set, repeat from 1.[5]

As VPython is a 3-D modeling system, I do not feel that I would be utilizing its full power simply representing a Koch snowflake. I intend to use VPython to create (and somehow analyze) a version of the Koch curve that repeats from a three-dimensional starting point.

If one were to start with a tetrahedron, the pattern could be adapted as such:

1. Take a regular tetrahedron.
2. Find the centroid of each outer face.
3. Place a regular tetrahedron of side length equal to 1/3 of the previous iteration's such that the centroid of one its faces lies on the midpoint (2) and that its base corners lie on the medians of the equilateral triangle.
4. For each tetrahedron, repeat from 1.[6]

Hopefully, I will be able to create a program in VPython that repeats recursively according to this process.

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[1] Khanbareh. H. (2011, December). *Fractal Dimension Analysis of Grain Boundaries of 7XXX Aluminum Alloys and Its Relationship to Fracture Toughness*. Retrieved from http://www.lr.tudelft.nl//fileadmin/Faculteit/LR/Images/NovAM/Pictures_research/MSc_projects/Hamide_thesis.pdf

[2] Kruhl, J.H. & Nega, M. (1996). *Geologische Rundschau, 85,* 38-43. *DOI:10.1007/BF00192058*

[3] And probably lots of other materials!

[4] See 1, 2.

[5] Adapted from http://mathworld.wolfram.com/KochSnowflake.html

[6] Surmised from a visualization by J. Sweeney: http://www.3dvision.com/wordpress/wp-content/uploads/2008/10/croppedfractal.jpg