

Crystal Notes

The Crystal

The crystal is defined as an ordered set of atoms (molecules) arranged in three (or more) dimensions. This is of course a slap in the face of the third law of thermodynamics. Ordered crystals exist because in their formation they must disorder their surroundings more than they are ordered. The key to growing a crystal is to cause in the disorder of the surroundings to be more than the order of the crystals.

When a crystal cools it's surrounding is heated. Inducing order in the crystal induces disorder in the atoms that surround it. The art of crystal growth is to regulate the rate of disorder in the surroundings.

Precipitation is another mechanism of crystal growth. Precipitation occurs from solution (a melt) where the crystallized molecules are solvated by smaller molecules. Driving solvent molecules from the precipitation induces an increase in the disorder of the solvent molecules themselves and thus is a form of increased disorder.

The rate of disordering is based upon the balance of ordered crystal and the disordered surroundings. In the best of all cases the disordered surrounding will be just greater than the ordered crystal. Minute fluctuations and random processes will slow the disorder and cause disorder in the crystal. In this way no crystal will be perfectly ordered.

Why we see a lot of plate-like crystals

The rate that any given crystal face grows is dependant on how fast material is deposited on that face and how well the material adopts positions that will accommodate orderliness. Most crystals grow on the side and bottom of the crystallization vessels. This will block at least one face from growing. Normally the best resting position of a crystal is on one of their largest faces, thus a naturally octahedron shaped crystal, when it grows on one side, will grow as a triangle plate. Most polyhedral shaped crystals will appear as plates if they grow from the crystallization vessels side or bottom.

Why do we see needle crystals

A needle is like a vector, when it grows it has direction and length. Needles start at a common point and grow outward. They act early along the direction of growth and shatters when cut perpendicular. Needle shaped crystals are due to their internal order, like stacking pizza boxes to the ceiling. Cut a needle shaped crystal and they will often shatter as to minimize the areas of obvious non-singularity.

To cut a needle, add it to oil. Using a very sharp blade such as a ruby or sapphire knife, place the blade perpendicular to the long axis of the crystal. Apply pressure to the blade; normally the weight of the blade is enough.

Common Crystal Habits

Common name	dimensions	face angles
Needle	$x = y \ll z$	90° 6 faces
Acicular	$x = y \ll z$	> 6 faces
Blade	$x < y \ll z$	90° 2 clear faces
Plate(y)	$x = y \gg z$	90° 6 faces
Tabular	$x = y \gg z$	> 6 faces
Block or cube	$x = y = z$	90° 6 faces
Truncated cube	$x = y = z$	> 6 faces
Prismatic	$x = y = z$	> 6 faces
Stretched cube	$x = y \neq z$	90° 4-fold axis
Diamond		
Octahedron	octahedral	8 faces
Truncated Octahedron	octahedral	> 8 faces
Tetrahedron	tetrahedral	35°
Rhombic dodecahedron	dodecahedral	
Parallelepiped	$x \neq y \neq z$	$\neq 90^\circ$
Polyhedron	catch all	ill regular shape

Crystal Colors (standard)

Brown	Brown
Red	Red
Orange	Orange
Yellow	Yellow
Green	Green
Blue	Blue
Violet	Violet
Colorless	no color, clear
Dark (color)	dark

Crystal Hardness

Mohs (M)	Vickers(V)	Reference	Formula
1	50	talc	$3\text{MgO} \cdot 4\text{SiO}_2 \cdot \text{H}_2\text{O}$
2	80	gypsum	$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
3	130	calcite	CaCO_3
4	200	fluorite	CaF_2
5	320	apatite	$\text{CaF}_2 \cdot 3\text{Ca}_3(\text{PO}_4)_2$
6	500	orthoclase	$\text{K}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2$
7	800	quartz	SiO_2
8	1300	topaz	$(\text{AlF}_2)_2 \cdot \text{SiO}_4$
9	2000	corundum	Al_2O_3
10	10,000	diamond	C