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Anatase

Anatase is a mineral form of titanium dioxide (TiO_2). The mineral is almost always encountered as a black solid, although the pure material is colorless or white. Two other mineral forms of TiO_2 are known, brookite and rutile.

Anatase is always found as small, isolated and sharply developed crystals, and like rutile, a more commonly occurring modification of titanium dioxide, it crystallizes in the tetragonal system; but, although the degree of symmetry is the same for both, there is no relation between the interfacial angles of the two minerals, except in the prism-zone of 45° and 90°. The common pyramid of anatase, parallel to the faces of which there are perfect cleavages, has an angle over the polar edge of 82°9', the corresponding angle of rutile being 56°52½'. It was on account of this steeper pyramid of anatase that the mineral was named, by René Just Haüy in 1801, from the Greek *anatasis*, "extension", the vertical axis of the crystals being longer than in rutile. There are also important differences between the physical characters of anatase and rutile: the former is less hard (5.5–6 vs. 6–6.5 Mohs) and dense (specific gravity about 3.9 vs. 4.2). Also, anatase is optically negative whereas rutile is positive, and its luster is even more strongly adamantine or metallic-adamantine than that of rutile.[4]

Anatase	
	
General	
Category	Oxide minerals
Formula (repeating unit)	TiO_2
Strunz classification	4.DD.05
Crystal system	Tetragonal
Crystal class	Ditetragonal dipyramidal (4/mmm) H-M symbol: (4/m 2/m 2/m)
Space group	$I4_1/amd$
Unit cell	a = 3.7845, c = 9.5143 [Å]; Z = 4
Identification	
Formula mass	79.88 g/mol
Color	Black, reddish to yellowish brown, dark blue, gray
Crystal habit	Pyramidal (crystals

Contents

Crystal habit

Two growth habits of anatase crystals may be distinguished. The more common occurs as simple acute double pyramids with an indigo-blue to black color and steely luster. Crystals of this kind are abundant at Le Bourg-d'Oisans in Dauphiné, where they are associated with rock-crystal, feldspar, and axinite in crevices in granite and mica-schist. Similar crystals, but of microscopic size, are widely distributed in sedimentary rocks, such as sandstones, clays, and slates, from which they may be separated by washing away the lighter constituents of the powdered rock.[4] The (101) plane of anatase is the most thermodynamically stable surface and is thus the most widely exposed facet in natural and synthetic anatase.[5]

Extended portion of the anatase lattice.

Crystals of the second type have numerous pyramidal faces developed, and they are usually flatter or sometimes prismatic in habit; the color is honey-yellow to brown. Such crystals closely resemble xenotime in appearance and, indeed, were for a long time supposed to belong to this species, the special name *wiserine* being applied to them. They occur attached to the walls of crevices in the gneisses of the Alps, the Binnenthal near Brig in canton Valais, Switzerland, being a well-known locality. Naturally occurring pseudomorphs of rutile after anatase are also known.[4]

While anatase is not an equilibrium phase of TiO_2, it is stable near room temperature. At temperatures between 550 and about 1000 °C, anatase converts to rutile. The temperature of this transformation strongly depends on the impurities or dopants as well as on the morphology of the sample.[6]

	are shaped like pyramids), tabular (form dimensions are thin in one direction).
Twinning	Rare on {112}
Cleavage	Perfect on [001] and [011]
Fracture	Subconchoidal
Tenacity	Brittle
Mohs scale hardness	5.5–6
Luster	Adamantine to splendent, metallic
Streak	pale yellowish white
Diaphaneity	Transparent to nearly opaque
Specific gravity	3.79–3.97
Optical properties	Uniaxial (-), anomalously biaxial in deeply colored crystals
Refractive index	$n_\omega = 2.561$, $n_\varepsilon = 2.488$
Birefringence	δ = 0.073
Pleochroism	Weak
References	[1][2][3]

Synthetic anatase

Due to its potential application as a semiconductor, anatase is often prepared synthetically. Crystalline anatase can be prepared in laboratories by chemical methods such as sol-gel method. Examples include controlled hydrolysis of titanium tetrachloride ($TiCl_4$) or titanium ethoxide. Often dopants are included in such synthesis processes to control the morphology, electronic structure, and surface chemistry of anatase.[7]

Alternate and obsolete names

Another name commonly in use for this mineral is *octahedrite*, a name which, indeed, is earlier than anatase, and given because of the common (acute) octahedral habit of the crystals. Other names, now obsolete, are oisanite and dauphinite, from the well-known French locality.[4]

See also

- List of minerals
- Adularia
- Delustrant

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