Description

Image

Image caption

(1) A cylindrical grinder (grinding machine) © Three-quarter-ten at Wikimedia Commons (CC BY-SA 3.0) (2) Man grinding a square tube. © Kleuske at Wikimedia Commons (CC BY-SA 3.0)

The process

GRINDING includes a group of processes that are used to shape materials that are too hard to be machined by conventional methods, and to improve precision and surface finish. The workpiece is held by a mechanical or magnetic grip that can be tracked or rotated beneath the grinding wheel (if small) or held stationary beneath the moving wheel (if large) while unwanted material is removed using an abrasive grinding wheel. Grinding works best on hard surfaces; soft metals smear and contaminate ("glaze") the wheel. Grinding processes are expensive and should be used only when absolutely necessary.

Process schematic

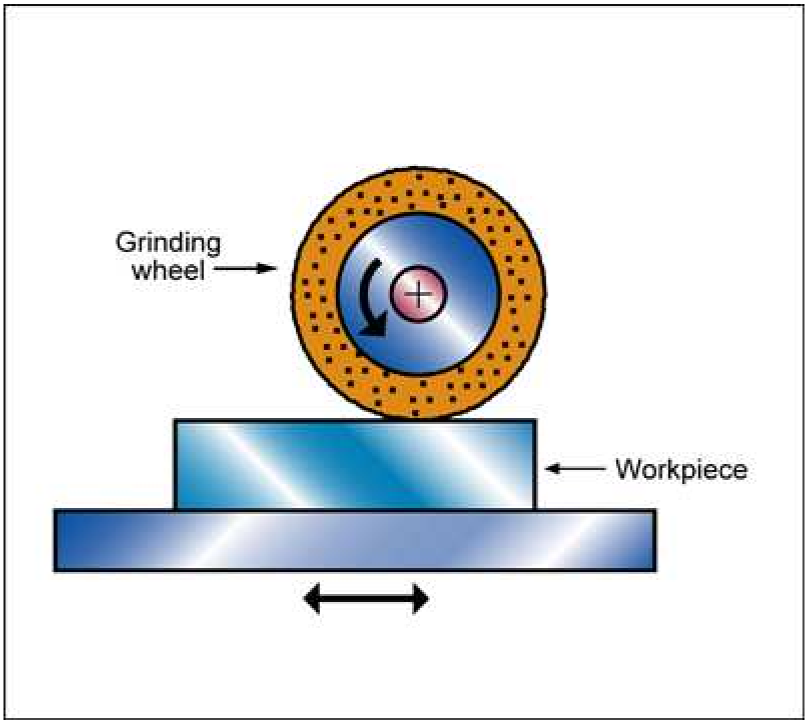

Figure caption

Grinding

Material compatibility

Ceramics	✔
Glasses	✔
Metals - ferrous	✔
Metals - non-ferrous	✔

Shape

Circular prismatic	✔
Non-circular prismatic	✔
Solid 3-D	✔
Hollow 3-D	✔

Economic compatibility

Relative tooling cost	low			
Relative equipment cost	high			
Labor intensity	medium			
Economic batch size (units)	10	-	1e6	

Physical and quality attributes

Mass range	0.00441	-	2.2e4	lb
Range of section thickness	39.4	-	3.93e4	mil
Tolerance	0.5	-	63	mil
Roughness	0.00787	-	0.063	mil
Surface roughness (A=v. smooth)	A			

Process characteristics

Primary shaping processes	✘
Machining processes	✔
Discrete	✔

Supporting information

Design guidelines

Grinding is usually applied to conical, cylindrical, flat or spherical surfaces, but the parabolic or elliptical surfaces (like that of a automobile cam-shaft) can also be ground. Where extreme precision is essential, as in accurate optical systems or in precision machine components, then mechanical grinding and polishing are the only choice.

Technical notes

Typical grinding abrasives are silicon carbide, SiC ("carborundum" or "corundum"), or alumina, Al2O3. Lubricants are used for cooling and to prevent glazing of the abrasive surface. Electro-discharge machining (of metals) can be used to replace grinding.

Typical uses

Machinery and structural parts such as pistons, pins, gears, shafts, rivets, valves, pistons, pins, gears, shafts, rivets, valves and pipe fittings, lenses and mirrors for precision optical equipment (ground and polished to a precision of better than 0.1 micron).

The economics

The equipment and tooling cost for manual grinding are low (capital cost, $100 - $1000; tooling cost $10 - $200) but the production rate is low. Those for automated grinding are greater (capital cost $20,000 - $1,000,000, tooling $1000 - $10,000) but with a higher production rate. Grinding is slow and therefore expensive; over-specification should be avoided.

The environment

The hazards depend on the workpiece, its surface coating and the type of abrasive system in place. Dust extraction required for some operations.

Links

MaterialUniverse

Reference