



Metalurgia do Pó

Introdução

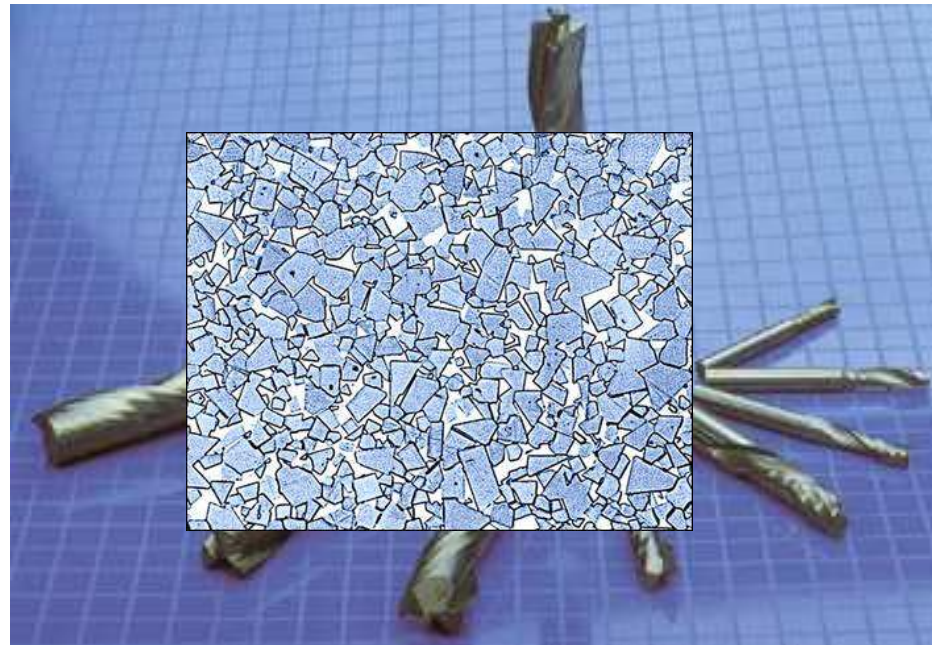


Peças automotivas e filtros





Metal Duro



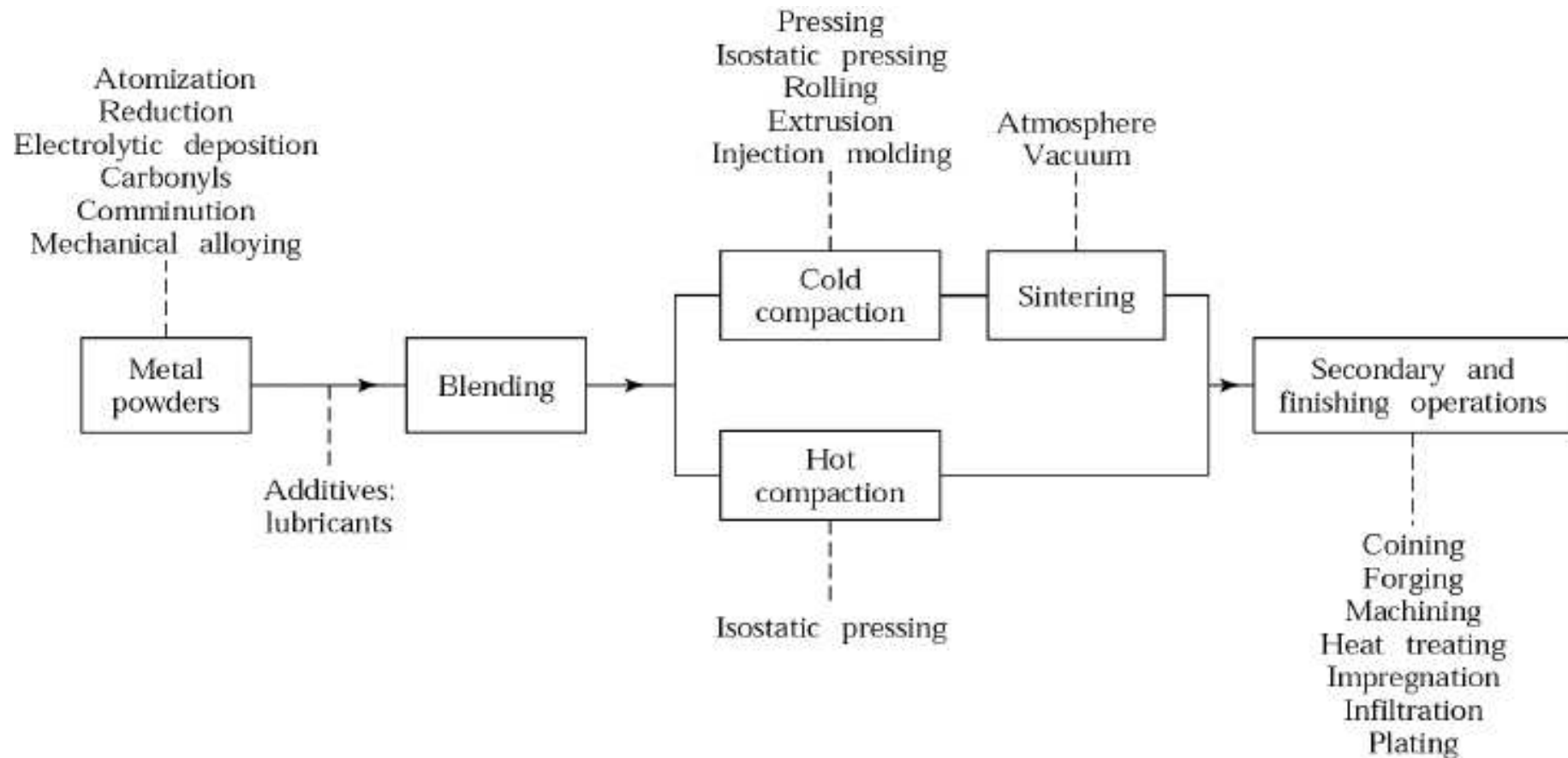


Aplicações

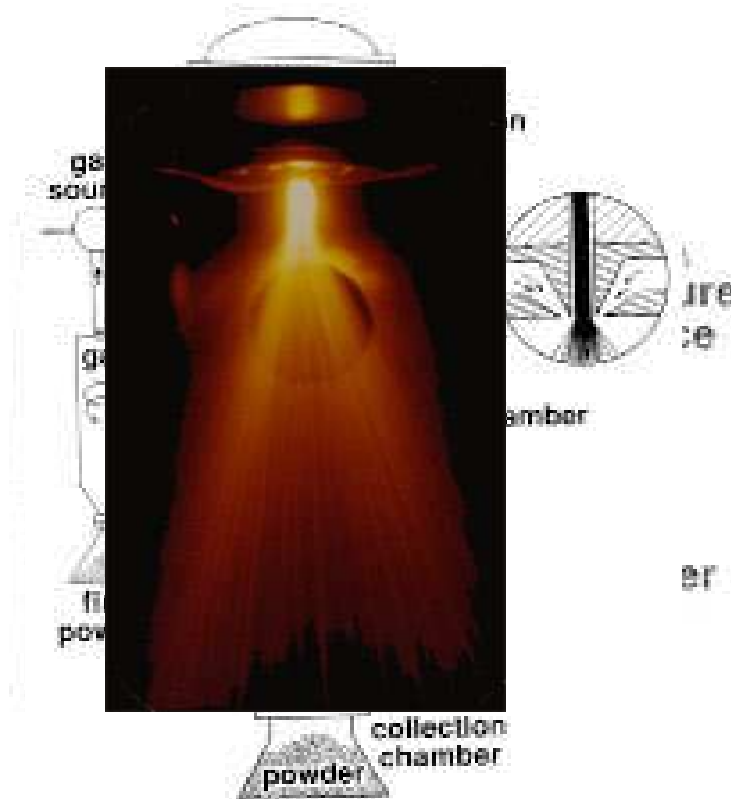
Application	Metals	Uses
Abrasives	Fe, Sn, Zn	Cleaning, abrasive wheels
Aerospace	Al, Be, Nb	Jet engines, heat shields
Automotive	Cu, Fe, W	Valve inserts, bushings, gears
Electrical/electronic	Ag, Au, Mo	Contacts, diode heat sinks
Heat treating	Mo, Pt, W	Furnace elements, thermocouples
Joining	Cu, Fe, Sn	Solders, electrodes
Lubrication	Cu, Fe, Zn	Greases, abradable seals
Magnetic	Co, Fe, Ni	Relays, magnets
Manufacturing	Cu, Mn, W	Dies, tools, bearings
Medical/dental	Ag, Au, W	Implants, amalgams
Metallurgical	Al, Ce, Si	Metal recovery, alloying
Nuclear	Be, Ni, W	Shielding, filters, reflectors
Office equipment	Al, Fe, Ti	Electrostatic copiers, cams

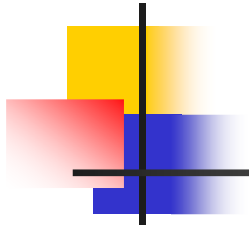
Source: R. M. German.

Esquema geral do processo



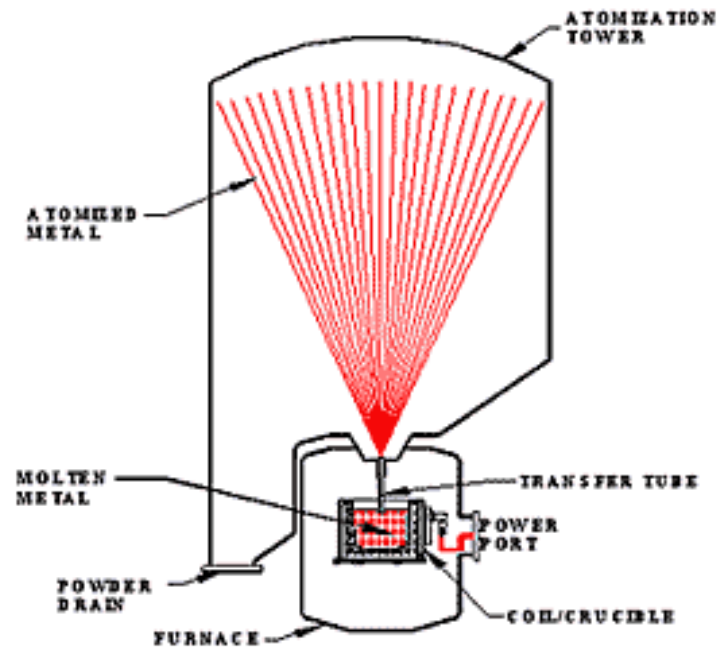
Atomização a água e a gás



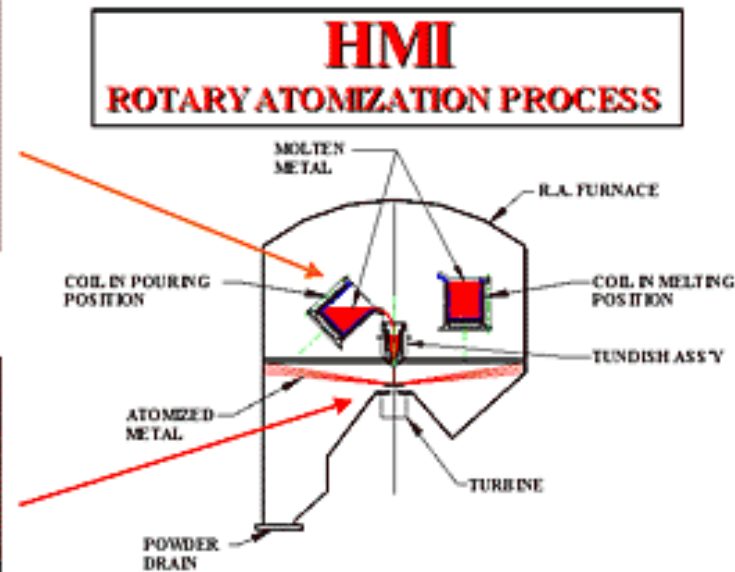


Atomização a vácuo

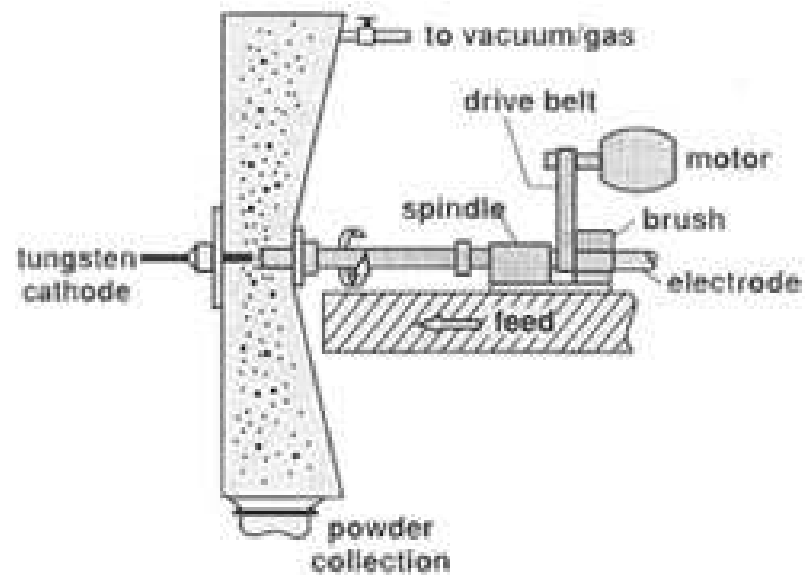
HMI ATOMIZATION PROCESS



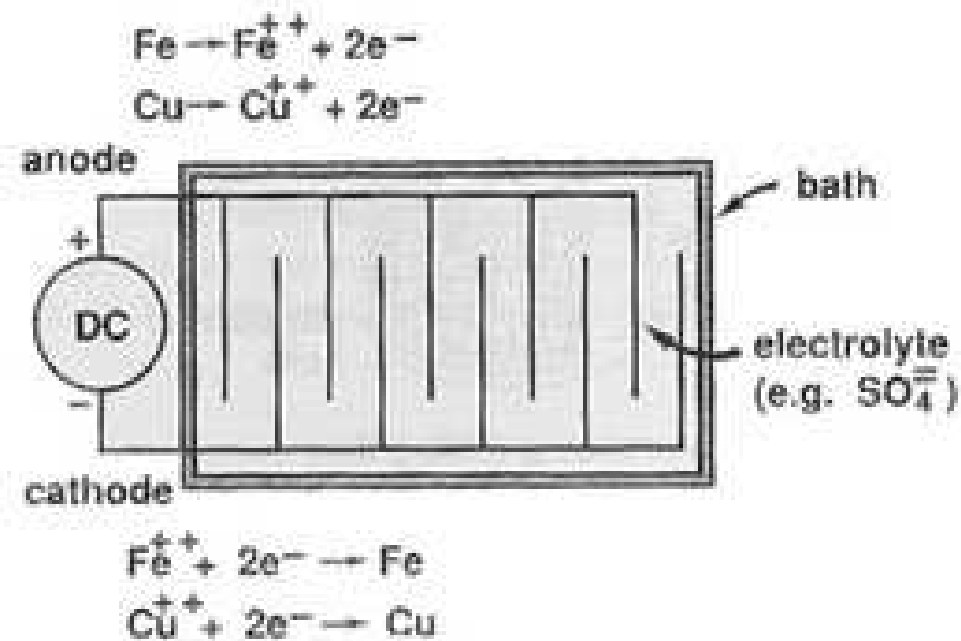
Atomização por disco rotativo



Atomização por eletrodo rotativo

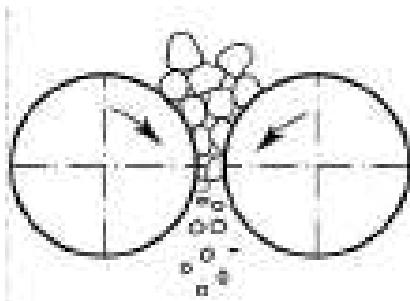


Deposição Eletrolítica





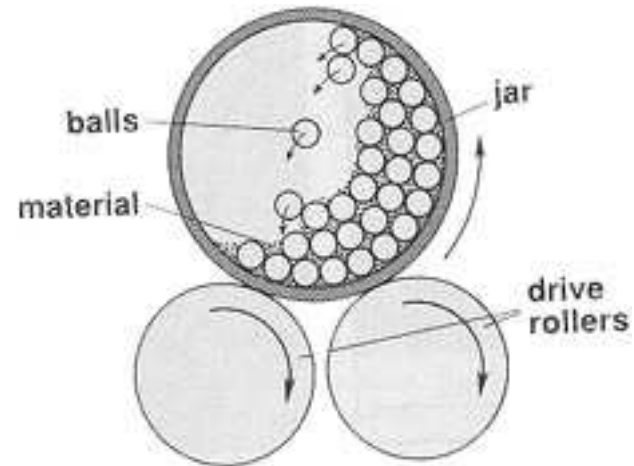
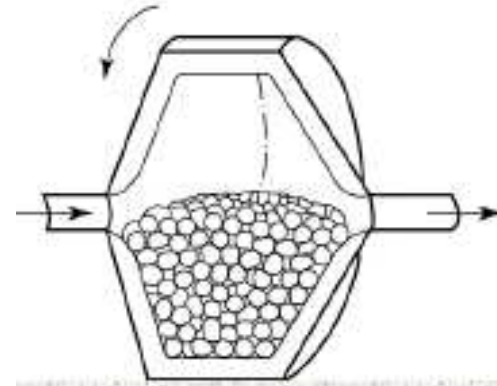
Moagem



Moinho de rolos

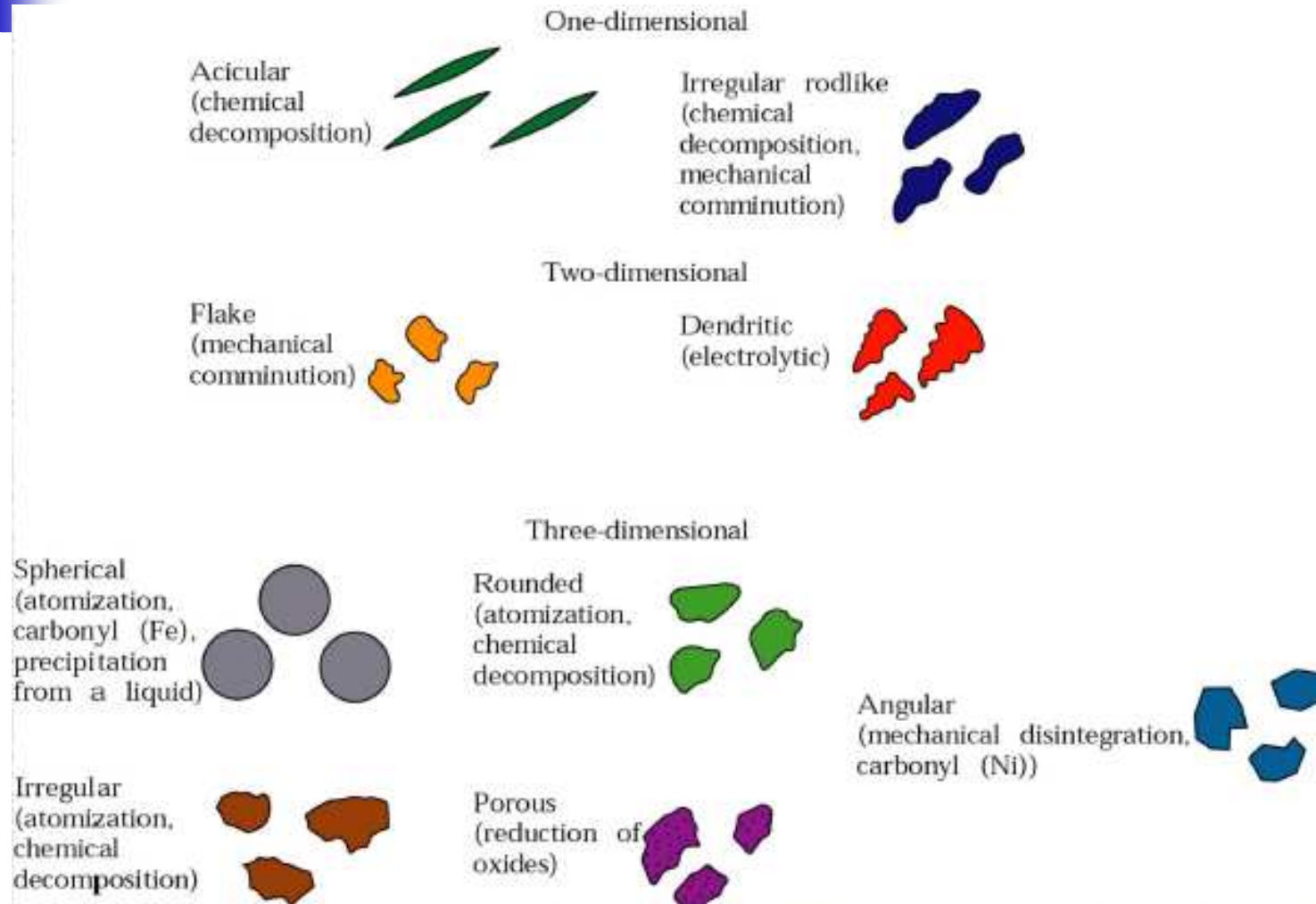


Moinho de martelos

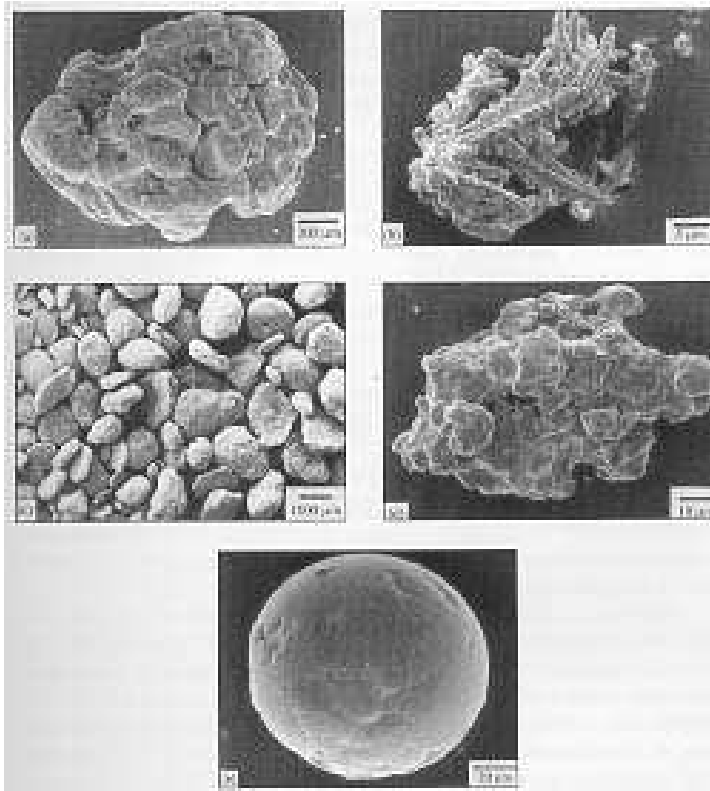


Moinho de bolas

Morfologia dos pós



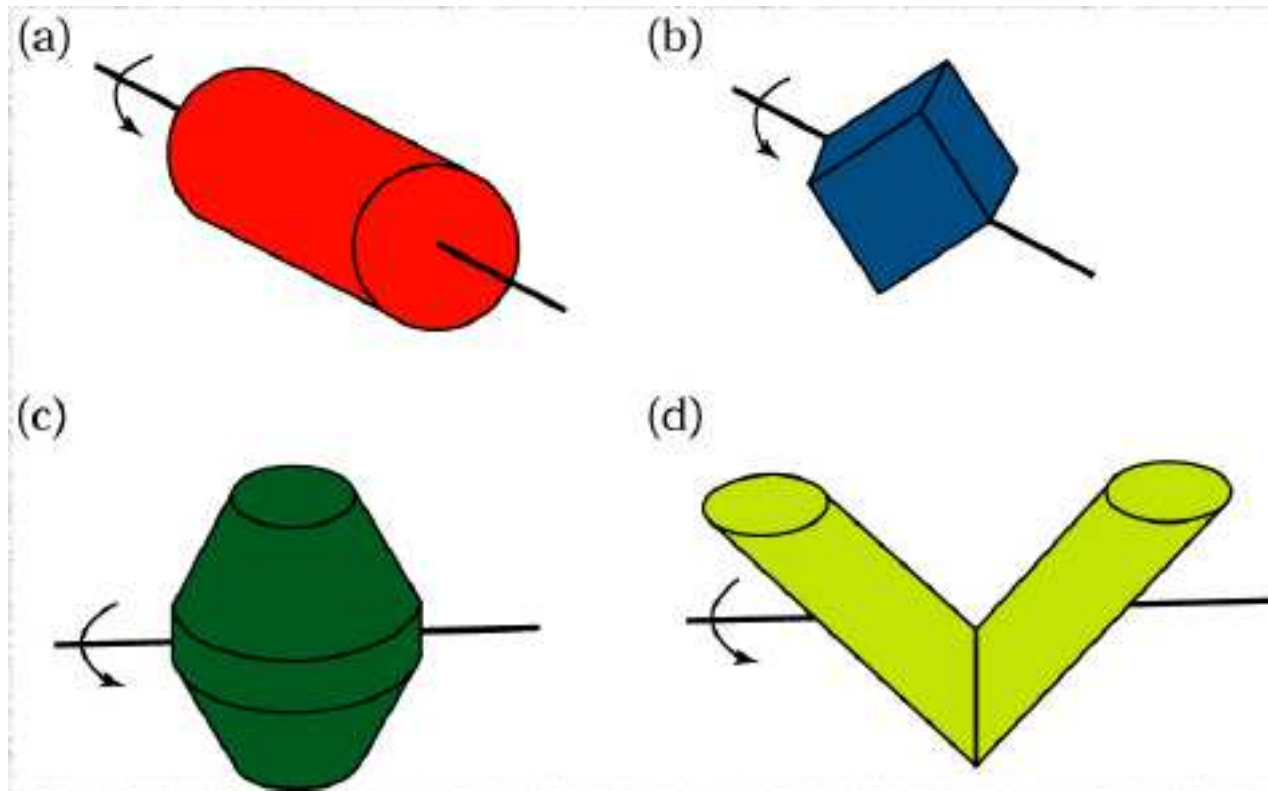
Morfologia dos pós



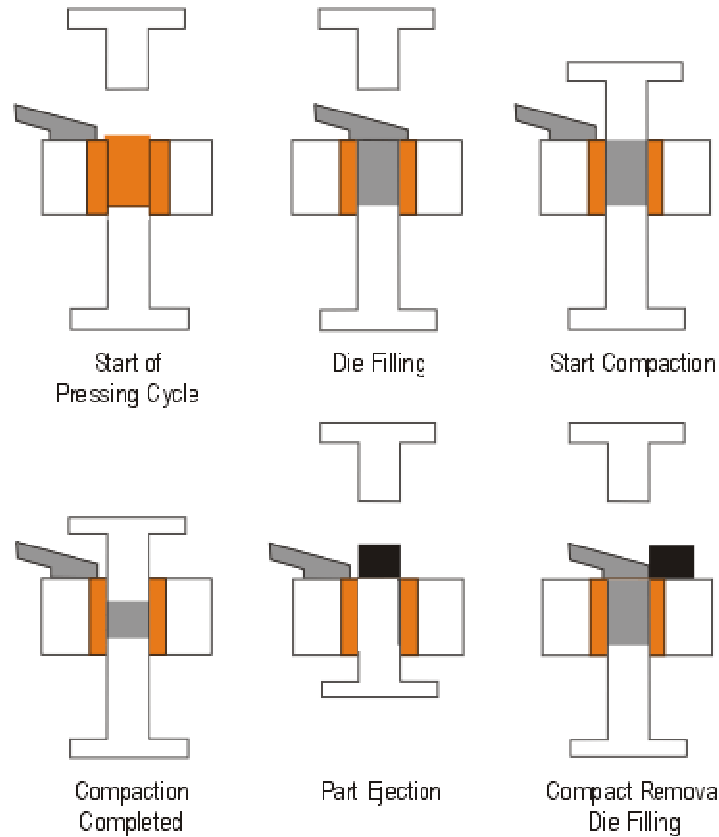
- a - redução do óxido
- b - deposição eletrolítica
- c - moagem
- d - atomização a água
- e - atomização a gás



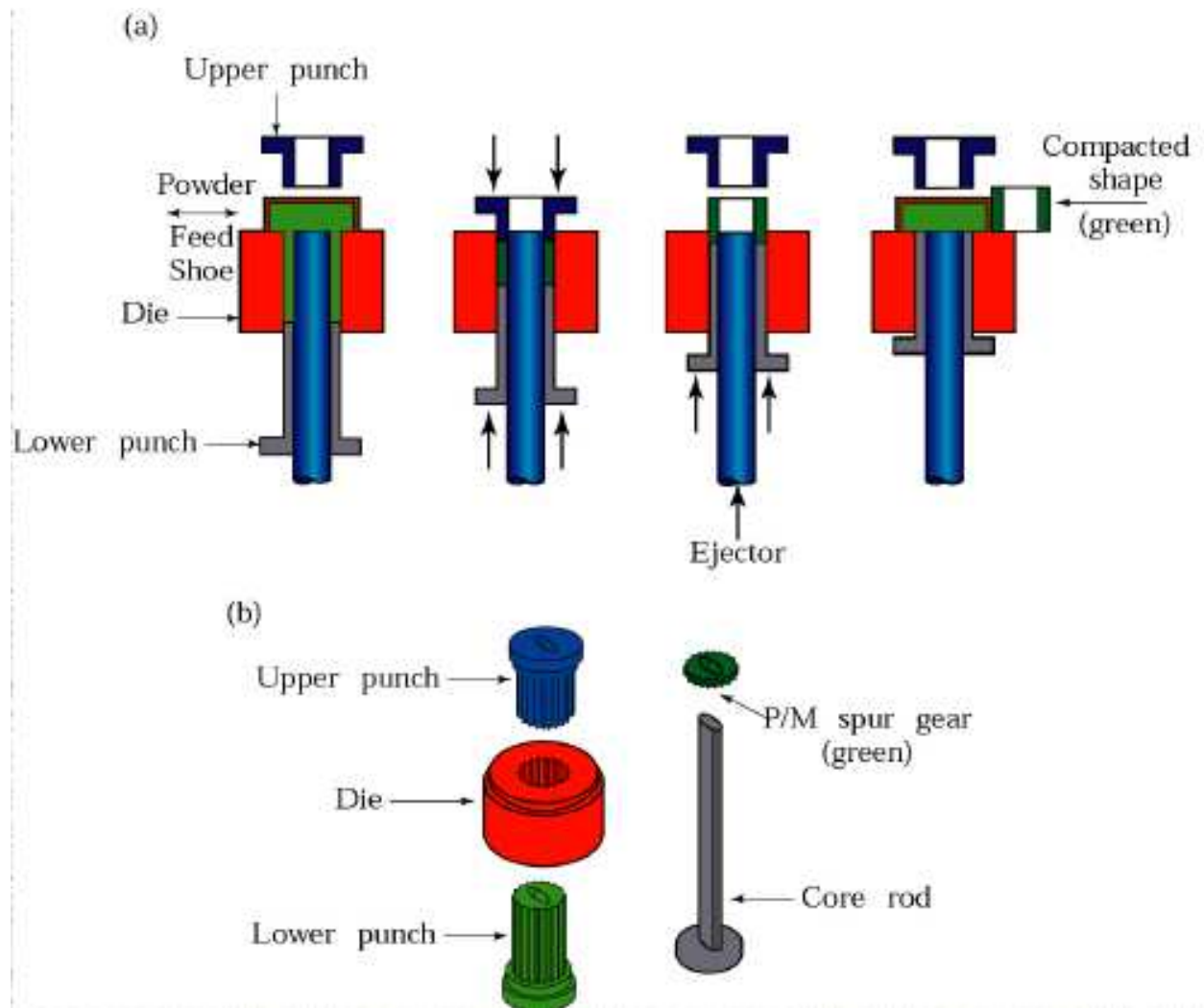
Misturadores

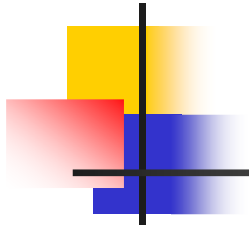


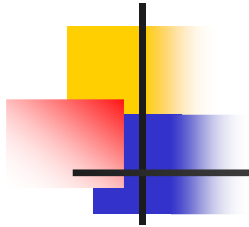
Prensagem uniaxial



Prensagem uniaxial





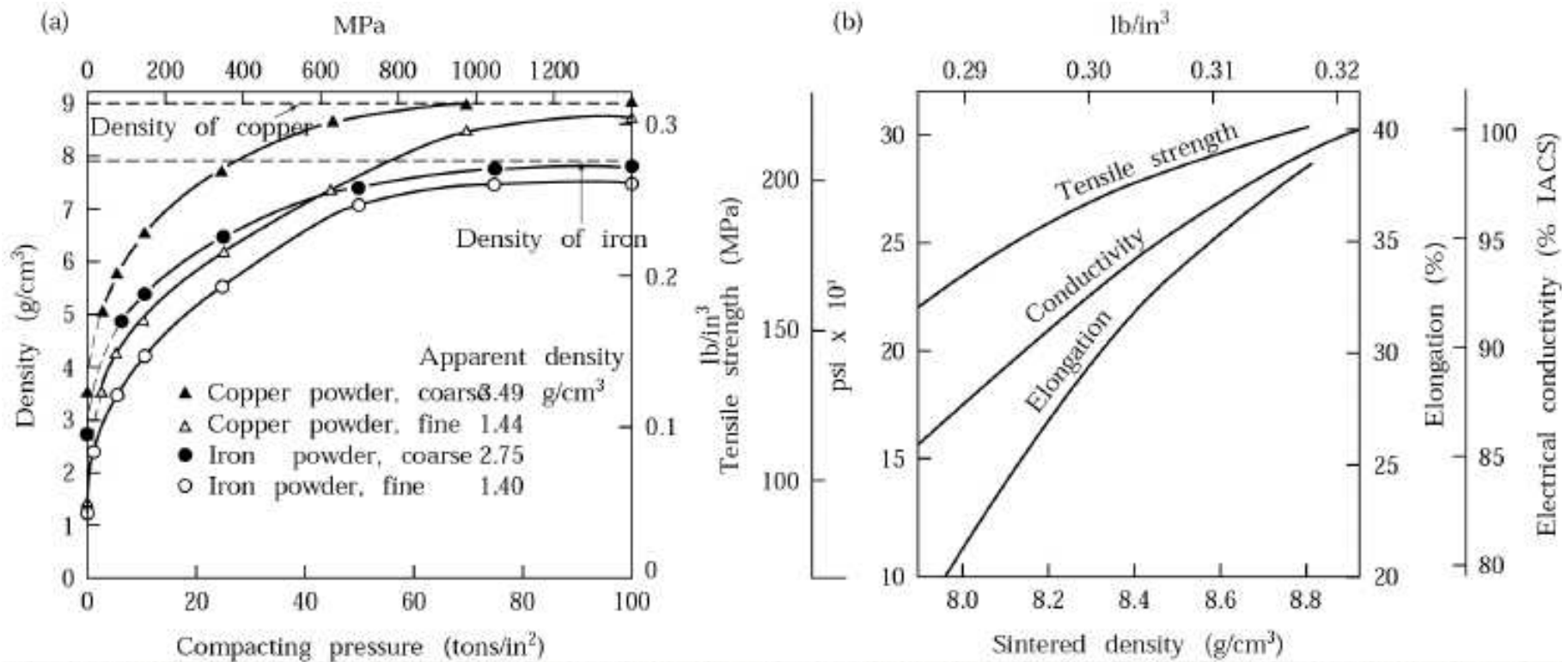




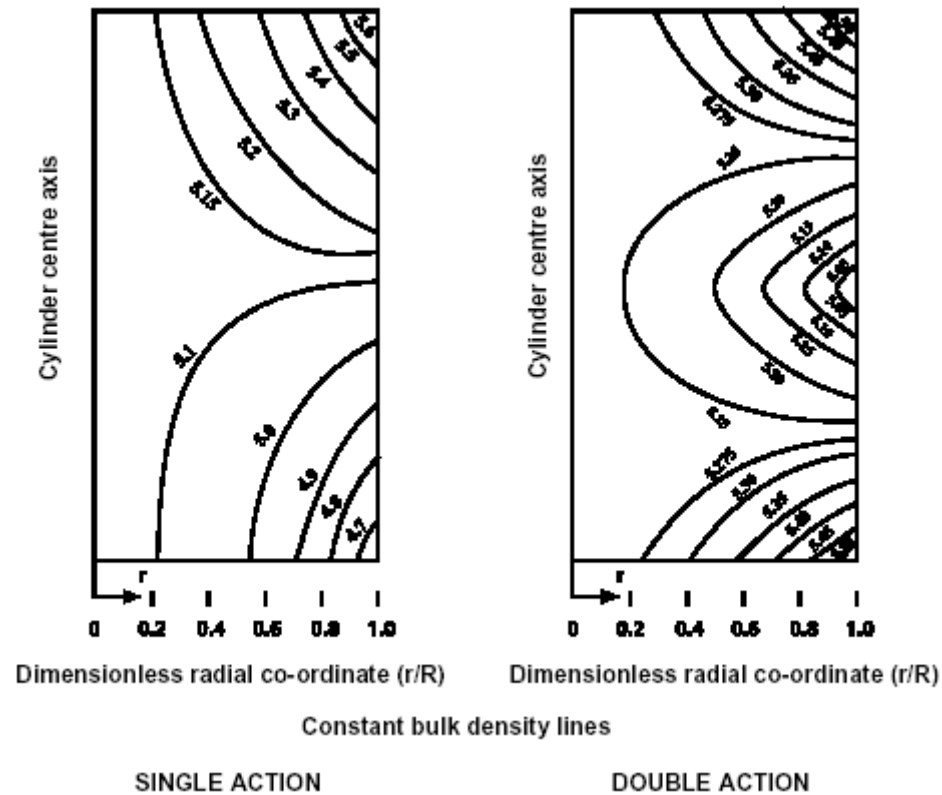
Pressões típicas

Metal	Pressure (MPa)
Aluminum	70–275
Brass	400–700
Bronze	200–275
Iron	350–800
Tantalum	70–140
Tungsten	70–140
Other materials	
Aluminum oxide	110–140
Carbon	140–165
Cemented carbides	140–400
Ferrites	110–165

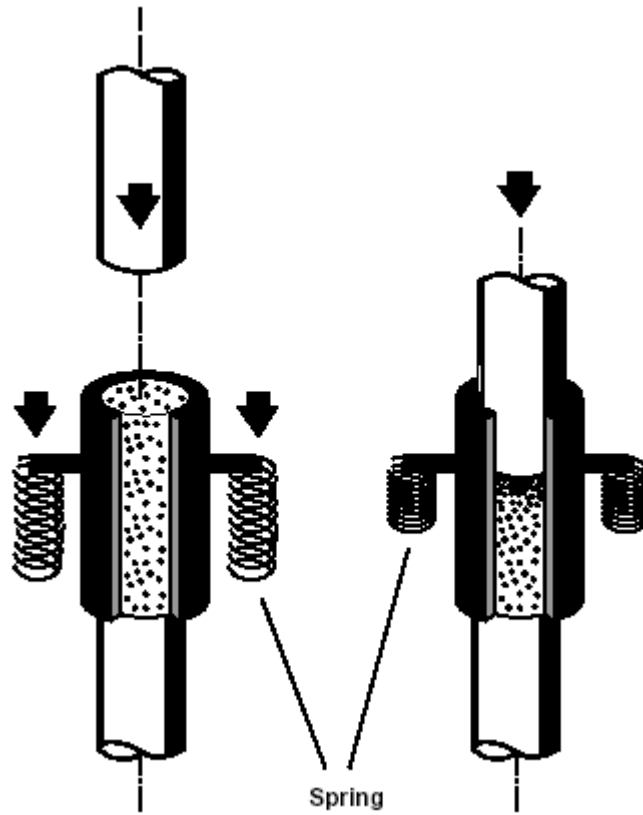
Efeitos da densidade



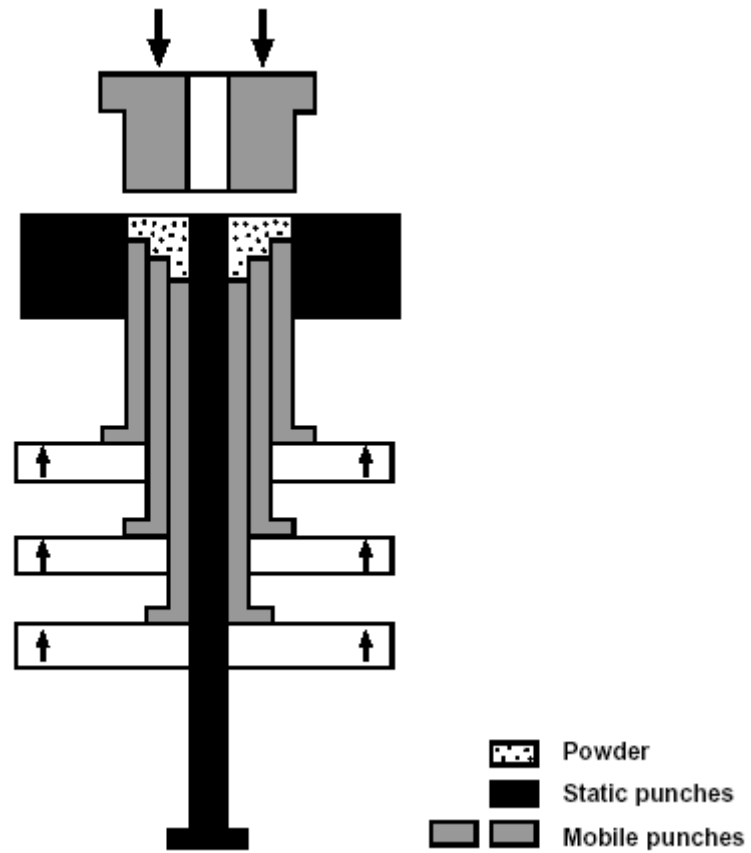
Distribuição de Densidades



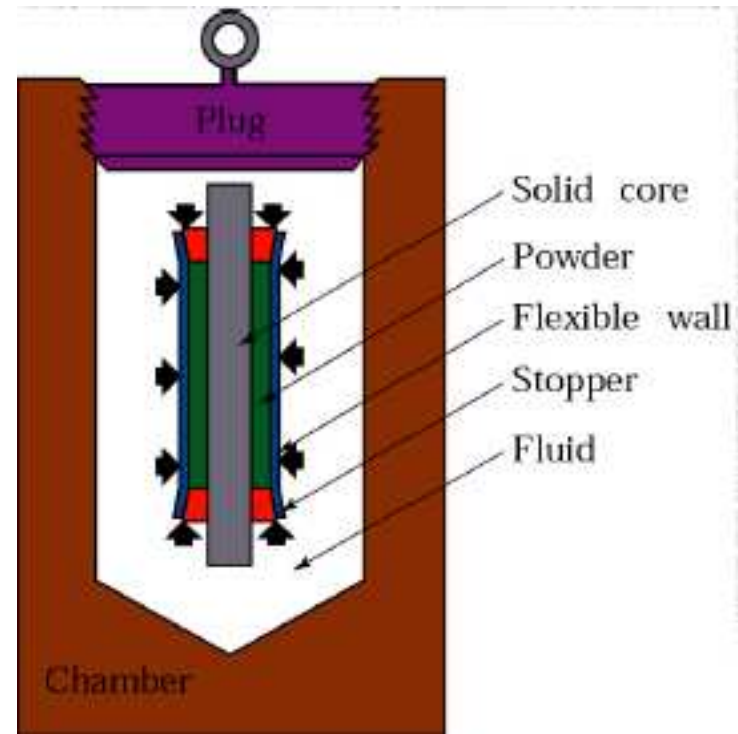
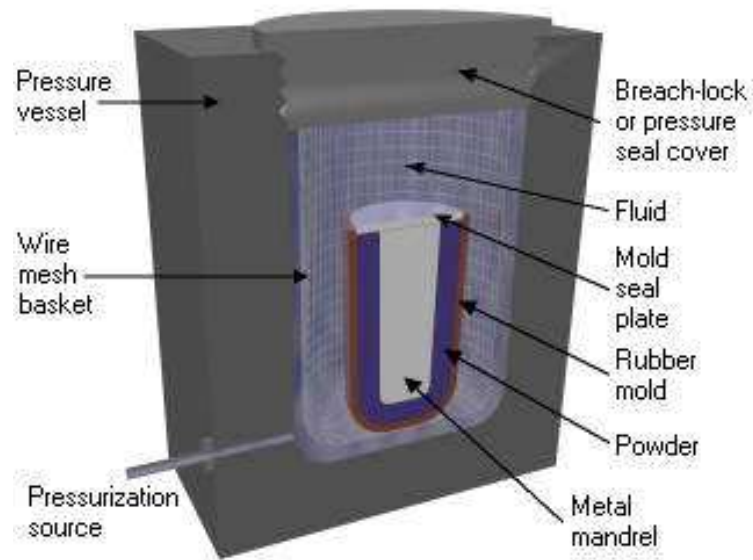
Matriz Flutuante



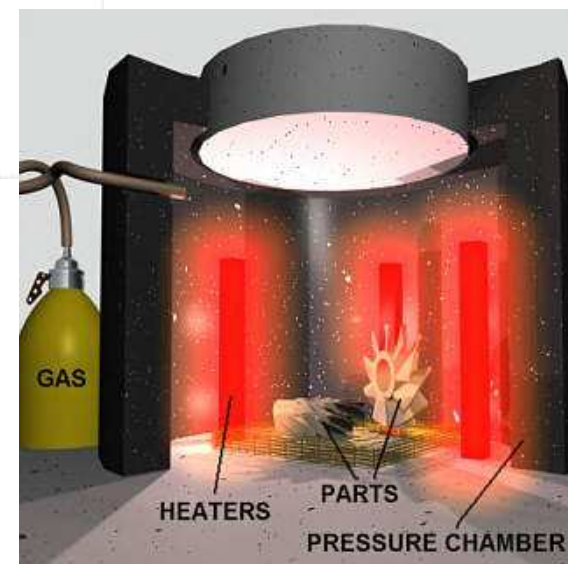
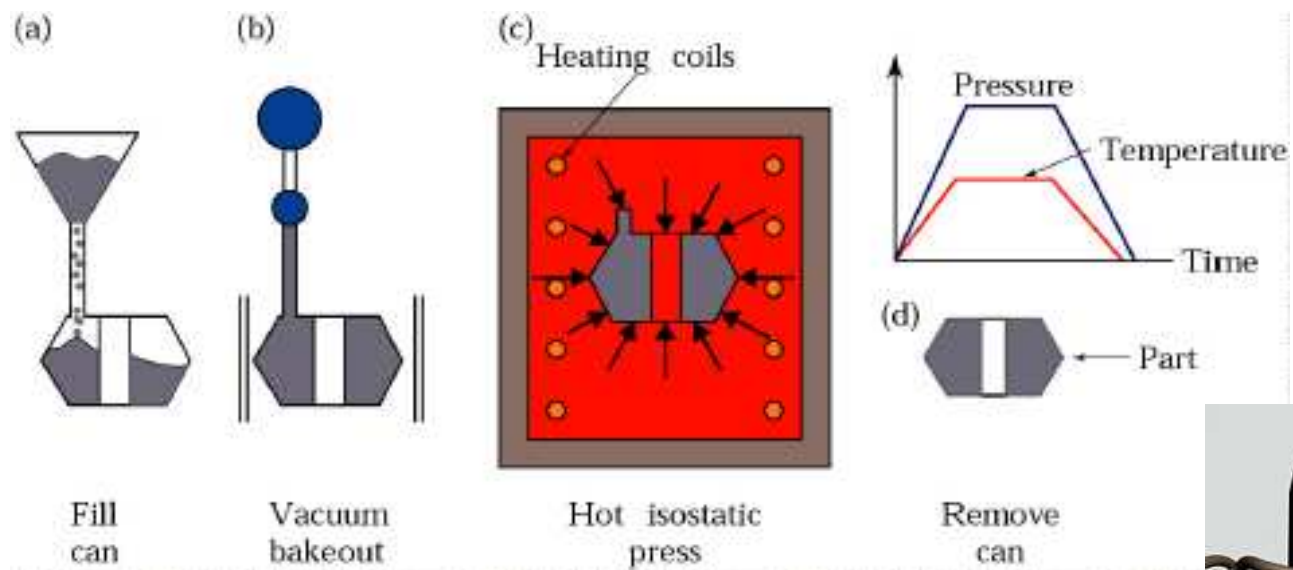
Múltiplos Estágios



Prensagem Isostática



Prensagem Isostática a Quente

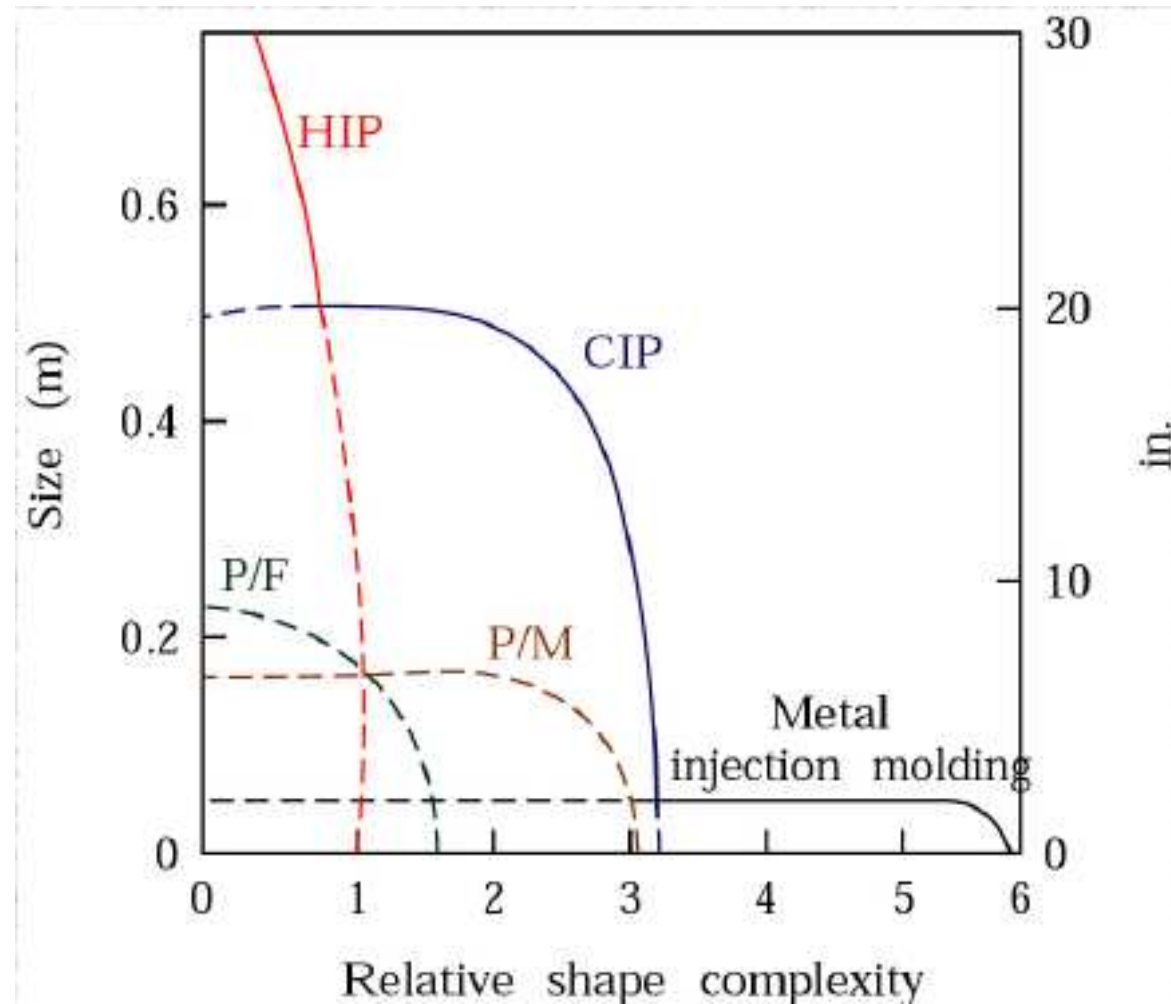




Injeção de pós

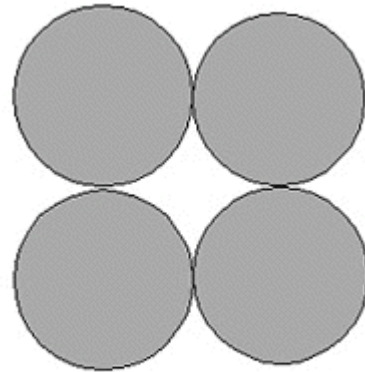


Comparação entre processos de compactação

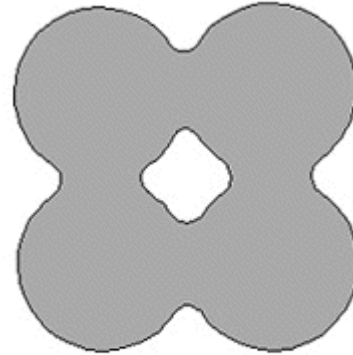




Sinterização



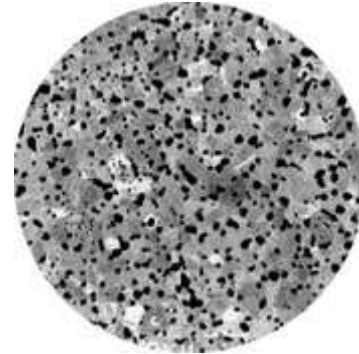
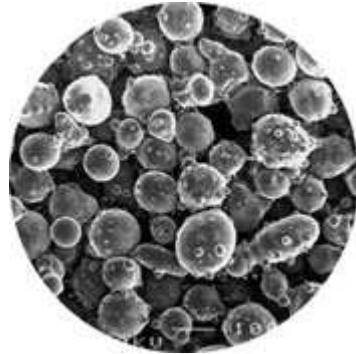
Representation of the initially unsintered powder particles.



Representation of Sintered Powder Particles



Sinterização



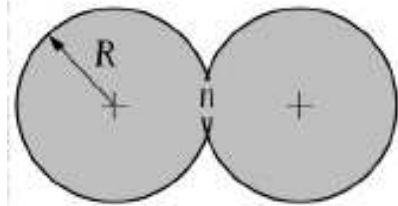
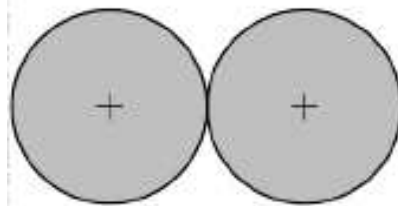


Sinterização

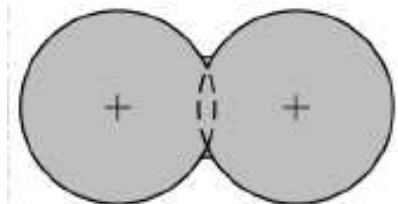


Mecanismos

(a) Difusão no sólido

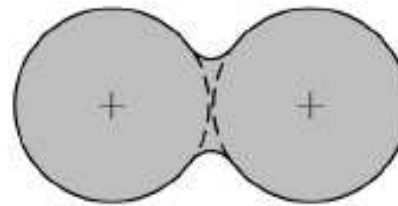
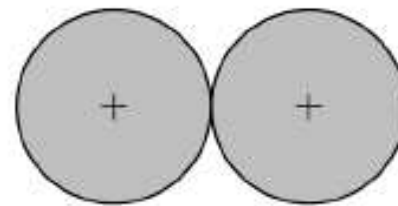


Neck formation
by diffusion

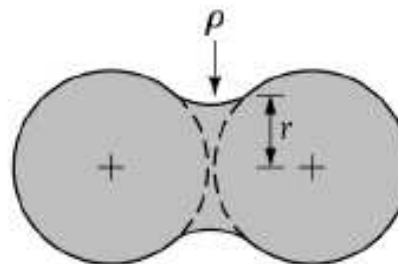


Distance between
particle centers
decreased, particles
bonded

(b) c/ presença de fase líquida



Neck formation
by vapor phase
material transport



Particles bonded,
no shrinkage (center
distances constant)



Temperaturas típicas

Material	Temperature (° C)	Time (Min)
Copper, brass, and bronze	760–900	10–45
Iron and iron-graphite	1000–1150	8–45
Nickel	1000–1150	30–45
Stainless steels	1100–1290	30–60
Alnico alloys (for permanent magnets)	1200–1300	120–150
Ferrites	1200–1500	10–600
Tungsten carbide	1430–1500	20–30
Molybdenum	2050	120
Tungsten	2350	480
Tantalum	2400	480



Operações de acabamento

- Tratamentos térmicos
- Reprensagem (Calibragem)
- Infiltração
- Acabamentos superficiais

Aspectos do design

