Hardness and strength of unalloyed uranium can be increased by warm or cold working.

- **Uranium alloys U-0.75Ti and U-2Mo**

	Melting point, °C	Density, Mg/m³
U-0.75Ti	1200	18.6
U-2Mo	1150	18.5

Mechanical properties of these two alloys vary widely with heat treatment. The standard heat treatment for ordnance applications consists of heating into the gamma phase (about 850 °C), quenching in water or oil, and then aging at any of various temperatures in the range 350 to 450 °C. Strength increases and ductility decreases with increasing aging temperature until the material reaches a peak-aged condition at about 450 °C. Above this temperature, the material becomes overaged and loses strength but gains in ductility. Typical tensile data are given in Tables 1 and 2 for underaged, peak aged and overaged material.

Table 1 Tensile properties of U-0.75% Ti (Ref 3)

Yield strength MPa	Yield strength ksi	Tensile strength MPa	Tensile strength ksi	Elonga-
Underaged				
700	101	1350	196	14
850	123	1450	210	13
1000	145	1525	221	7½
Peak aged				
1200	174	1650	239	2½
Overaged				
1000	145	1450	210	3
850	123	1300	188	4
700	101	1175	170	7

Table 2 Tensile properties of U-2% Mo (Ref 3)

Yield strength MPa	Yield strength ksi	Tensile strength MPa	Tensile strength ksi	Elongation, %
Underaged				
700	101	1150	167	4
850	123	1200	174	4
1000	145	1250	181	2½
1150	167	1350	196	1½
Peak aged				
1350	196	1600	232	1½
Overaged				
1150	167	1375	199	1½
1000	145	1400	203	3½
850	123	1225	178	8
700	101	1125	163	17
550	80	925	134	24

Production and Availability

Natural uranium (NU) contains about 0.7% of the fissionable isotope U-235, the remainder being comprised almost entirely of the isotope U-238. Power reactors of the type built in the United States require a U-235 content of 3%. Uranium is enriched from 0.7 to 3% U-235 by the gaseous diffusion process, in which the uranium is present as uranium hexafluoride (UF_6). Five to six kilograms of depleted uranium containing 0.2 to 0.3% U-235 are produced for each kilogram of uranium that is enriched to 3% U-235.

Depleted uranium (DU) is available mainly from government sources in the form of uranium hexafluoride (UF_6) or uranium tetrafluoride (UF_4); UF_4 also is known as "green salt." The amounts of depleted uranium estimated to be available for non-nuclear uses in 1978 through 1988 are shown in Table 3.

Table 3 Estimated availability of depleted uranium (a)

	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87	'88
UF_6	184.8	202.1	213.0	228.5	250.8	273.2	297.8	324.5	351.1	377.8	405.3
UF_4	67.7	63.5	50.2	45.7	44.6	37.4	35.0	32.5	27.9	27.9	27.9
Total....	252.5	265.6	263.2	274.2	295.4	310.6	332.8	357.0	379.0	405.7	433.2

(a) Metric tons (Mg) of metal. Data from U.S. Department of Energy (Feb 1979).

Green salt (UF_4) is obtained by chemically reducing UF_6 with hydrogen. Green salt is reduced to metal by an exothermic reaction with magnesium in a closed vessel. The product of this reaction is high-purity unalloyed uranium in the shape of a short cylinder, known as a "derby", weighing between 150 and 500 kg. Figure 2 shows schematically the steps involved in producing depleted uranium metal from the ore. At present there are five industrial producers of depleted uranium products for non-nuclear use in the United States and one in Canada.

Methods of Fabrication

The starting material for all depleted uranium products is derby metal. The usual methods of fabrication of DU products include casting, extrusion, rolling, and forging and swaging; these methods are discussed below. Almost all other conventional metalworking processes (including drawing, spinning, tube drawing, die forging and roll straightening) have been applied to DU, but few are of commercial significance.

Melting and Casting. Uranium can be melted by any of several different techniques. However, because uranium is very reactive when heated in air, melting must be done either under a protective inert atmosphere or in vacuum. Also, because uranium reacts with most ordinary crucible materials, it must be melted in a graphite crucible.

Uranium for industrial non-nuclear uses is melted in cold-wall vacuum induction furnaces (Ref 4). Crucibles and molds are made of high-density graphite. To prevent the uranium from contamination by carbon picked up