



Specialists in Rare Earth Magnets and Magnet Systems

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## What is rare earth?

Rare earth (RE) metals are critical materials for modern technologies, ranging from cell phones, fluorescent light bulbs, computers, office and home appliances, medical devices, hybrid vehicles and wind turbines. In the last 20 years, the demand for many devices that require rare earth metals has been increased exponentially primarily due to some of the very popular electronic devices such as cell phones, DVDs, and computers. Portable electronic devices and electric vehicles also drive the demand for the rechargeable batteries, which are also produced with rare earth compounds. Rare earth elements are also used as catalysts, phosphors and polishing compounds.

Rare earth elements also play an essential role in aerospace and military systems, such as night-vision goggles, precision guidance systems, nuclear powered submarines, fighter jets, missile systems, and satellite systems.

Rare-earth metals include scandium (Sc-21), yttrium (Y-39) and the lanthanides — lanthanum (La-57), cerium (Ce-58), praseodymium (Pr-59), neodymium (Nd-60), promethium (Pm-61), samarium (Sm-62), europium (Eu-63), gadolinium (Gd-64), terbium (Tb-65), dysprosium (Dy-66), holmium (Ho-67), erbium (Er-68), thulium (Tm-69), ytterbium (Yb-70), and lutetium (Lu-71). Scandium and yttrium are considered rare earth elements because they have similar chemical properties and often occur in the same ore deposits as the lanthanides.

Rare earth metals, despite its name, are not rare (with the exception of the radioactive promethium) and they are not “earth”. In fact they are relatively plentiful in the Earth's crust. The most abundant rare earth metals are cerium, yttrium, lanthanum and neodymium. However, these metals are very difficult to mine because the concentrations are normally too low for economical extraction.

China is currently the world's dominant producer and consumer of rare earth elements. In early 2010 China accounted for over 95% of the world's rare earth production although China has

just over 1/3 of the world known deposits of rare earth minerals. In recent years, China has been restricting their rare earth exports to ensure a supply for domestic manufacturing, which caused significant price volatility. There are a number of rare earth mines at various stages outside China including Molycorp Minerals, USA, Lanase Corporation, Australia, and Great Western Minerals, Canada.

The following table listed all the rare earth metals and their physical properties for reference.

Table 1: rare earth metals and their physical properties

Rare earth element	Symbol	Atomic number	Atomic weight	Density (g/cm <sup>3</sup> )	Melting point (°K)	Crystal Structure
Scandium	Sc	21	44.955	2.958	1814	Hexagonal
Yttrium	Y	39	88.905	4.472	1799	Hexagonal
Lanthanum	La	57	138.905	6.162	1193	Hexagonal
Cerium	Ce	58	140.116	6.77	1068	Cubic face centered
Praseodymium	Pr	59	140.907	6.77	1208	Hexagonal
Neodymium	Nd	60	144.242	7.01	1297	Hexagonal
Promethium	Pm	61	145	7.26	1315	Hexagonal
Samarium	Sm	62	150.36	7.52	1345	Rhombohedral
Europium	Eu	63	151.964	5.264	1099	Cubic body centered
Gadolinium	Gd	64	157.25	7.90	1585	Hexagonal
Terbium	Tb	65	158.925	8.23	1629	Hexagonal
Dysprosium	Dy	66	162.50	8.54	1680	Hexagonal
Holmium	Ho	67	164.930	8.79	1734	Hexagonal
Erbium	Er	68	167.259	9.066	1802	Hexagonal
Thulium	Tm	69	168.934	9.32	1818	Hexagonal
Ytterbium	Yb	70	173.04	6.90	1097	Cubic face centered
Lutetium	Lu	71	174.967	9.841	1925	Hexagonal

The following figure shows the position of these rare earth elements in the periodic table.

		<b>Sc</b>																		
		<b>Y</b>																		

<b>La</b>	<b>Ce</b>	<b>Pr</b>	<b>Nd</b>	<b>Pm</b>	<b>Sm</b>	<b>Eu</b>	<b>Gd</b>	<b>Tb</b>	<b>Dy</b>	<b>Ho</b>	<b>Er</b>	<b>Tm</b>	<b>Yb</b>	<b>Lu</b>

Figure 1. Positions of rare earth elements in the periodic table