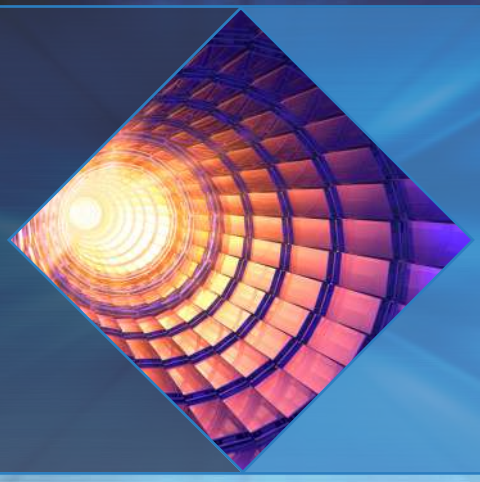
RECOMA® HT
Rare Earth Magnets for High Temperatures



Abstract

Arnold Magnetic Technologies has developed Samarium Cobalt magnets for a wide range of applications. The RECOMA®HT grade magnets were developed specifically for applications operating at extremely high temperatures (360°C to 520°C).

RECOMA®HT's properties also make it the ideal magnet choice for applications that experience ionizing radiation. Coated Sm_2Co_{17}-type magnets are the preferred choice for space applications or in in-vacuum applications like particle accelerators.

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Arnold Magnetic Technologies

ARNOLD® MAGNETIC TECHNOLOGIES

Magnets Working at Higher Temperature

In permanent magnet applications, the maximum operating temperature generally is far below the Curie temperature of the material. The operating temperature is usually limited by the decrease of the coercive field with increasing temperature. Depending on the load line, the demagnetizing field in a magnet will be large enough to induce irreversible losses at temperatures much below the Curie temperature. Therefore, it is important to consider the shape of the demagnetization curve at operating temperature.

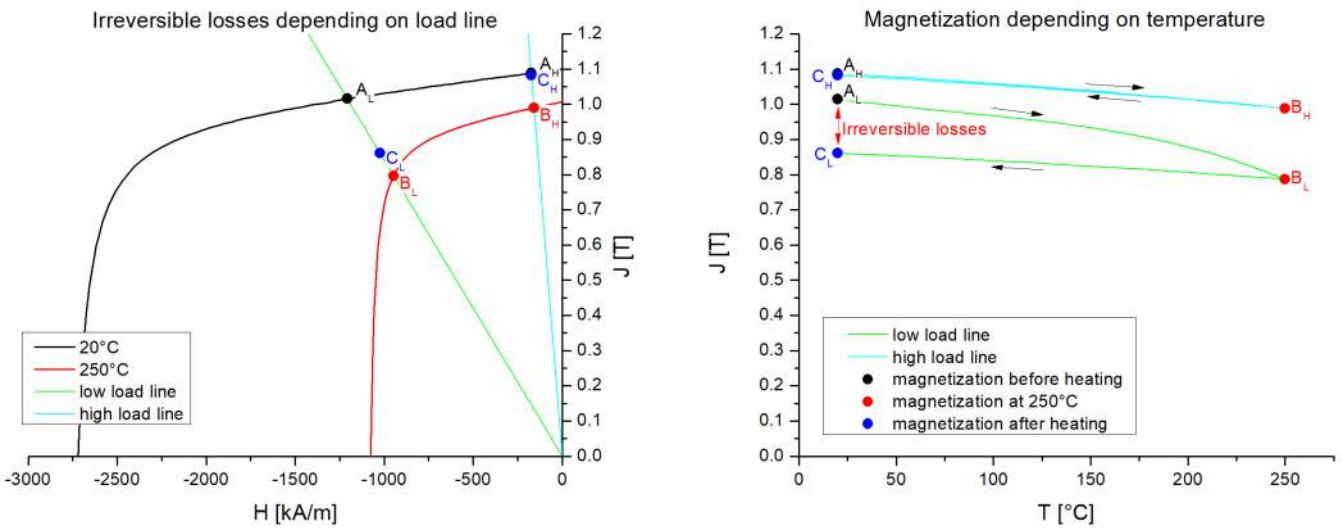


Figure 1

The points A_L and A_H describe the magnetizations at 20°C for magnets operating on two different load lines. B_L and B_H show the magnetizations at 250°C. After cooling to 20°C, the two magnets have the magnetizations C_L and C_H. While the magnet working on a high load line has almost the same magnetization as before, the magnet on a low load line now has a much lower magnetization. Irreversible losses have occurred.

Reversible Temperature Coefficient of H_{cJ}

In NdFeB type magnets, the coercive field decreases rapidly with increasing temperature. In order to have sufficient coercivity at higher temperature, the room temperature coercive field needs to be very high in these magnets. For operating temperatures above 180°C, EH and AH grade magnets are usually required.

In Sm_2Co_{17} type magnets, the decrease of coercivity with temperature is generally much smaller than in NdFeB. And, in contrast to NdFeB materials, changes in chemistry and microstructure make it possible to further reduce the reversible temperature coefficient (RTC) of the coercivity to very low values. Some reports even indicate increasing coercivity over limited temperature ranges. High coercivity at elevated temperatures can thus be achieved without creating excessive coercive field at room temperature. Whereas the standard Recoma 28HE has a RTC(H_{cJ}) of about 0.26%/K between 20 to 300°C, the high temperature grade Recoma HT520 shows only 0.14%/K. Although the Recoma HT grades may have a significantly lower room temperature coercivity, as compared to our standard grades or to high temperature NdFeB grades, they can be used at much higher temperatures.

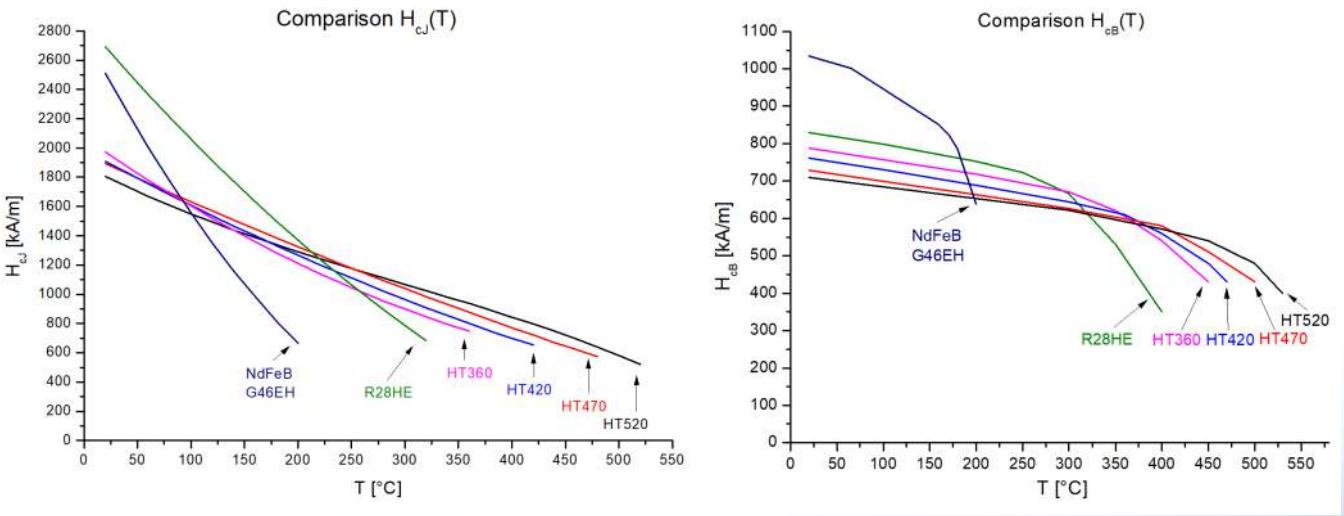


Figure 2 - Comparison of H_{cJ} and H_{cB} of different grades.

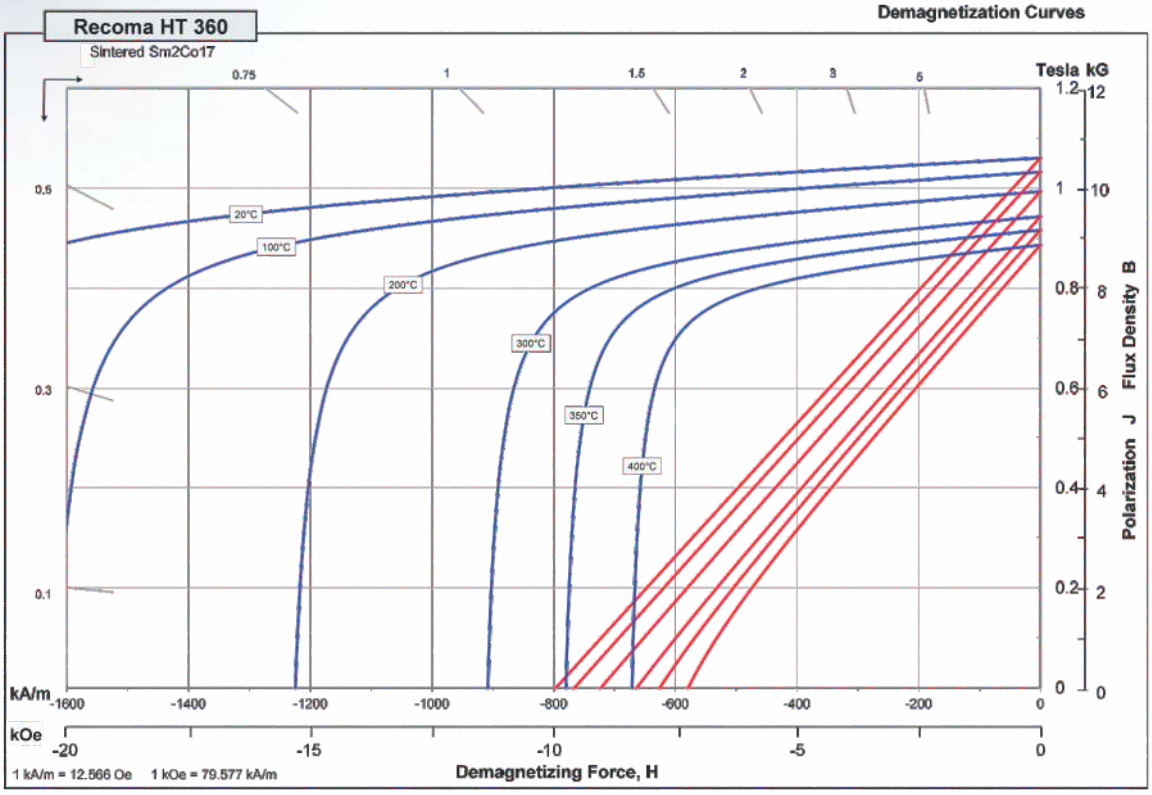
Magnetic Properties

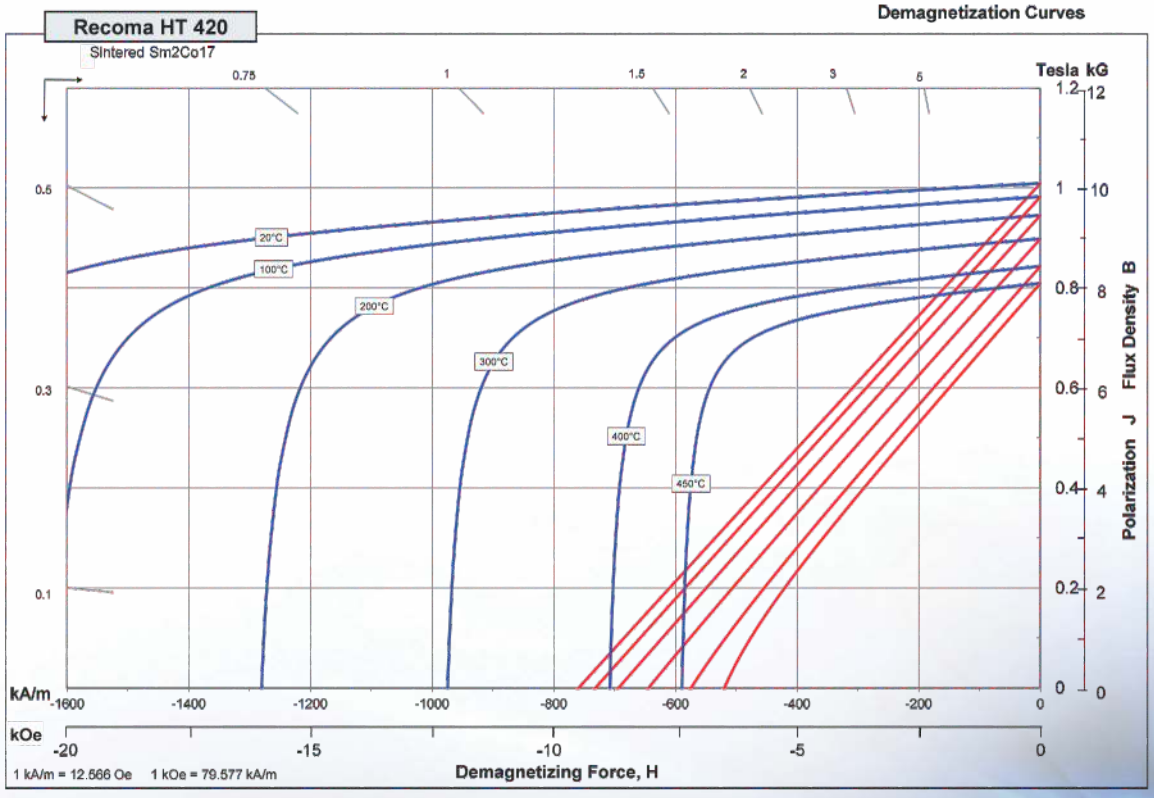
Improved high temperature performance is accompanied by a moderate reduction of the remanence B_R. Typical room temperature values for isostatically pressed Recoma HT magnets are shown in the table below:

	B_R [T]		$(BH)_{Max}$ [kJ/m³]		H_{cB} [kA/m]		H_{cJ} [kA/m]		Density [g/cm³]	Max. Operating Temp. [°C] (1)
	typ.	min.	typ.	min.	typ.	min.	typ.	min.	typ.	
Recoma 28HE	1.10	1.06	225	215	805	775	>2000	1500	8.40	290
Recoma HT360	1.06	1.01	210	190	790	740	1900	1600	8.40	360
Recoma HT420	1.02	0.98	195	180	760	720	1900	1600	8.43	420
Recoma HT470	0.97	0.92	178	160	730	680	1900	1600	8.45	470
Recoma HT520	0.94	0.89	170	150	715	665	1800	1600	8.50	520

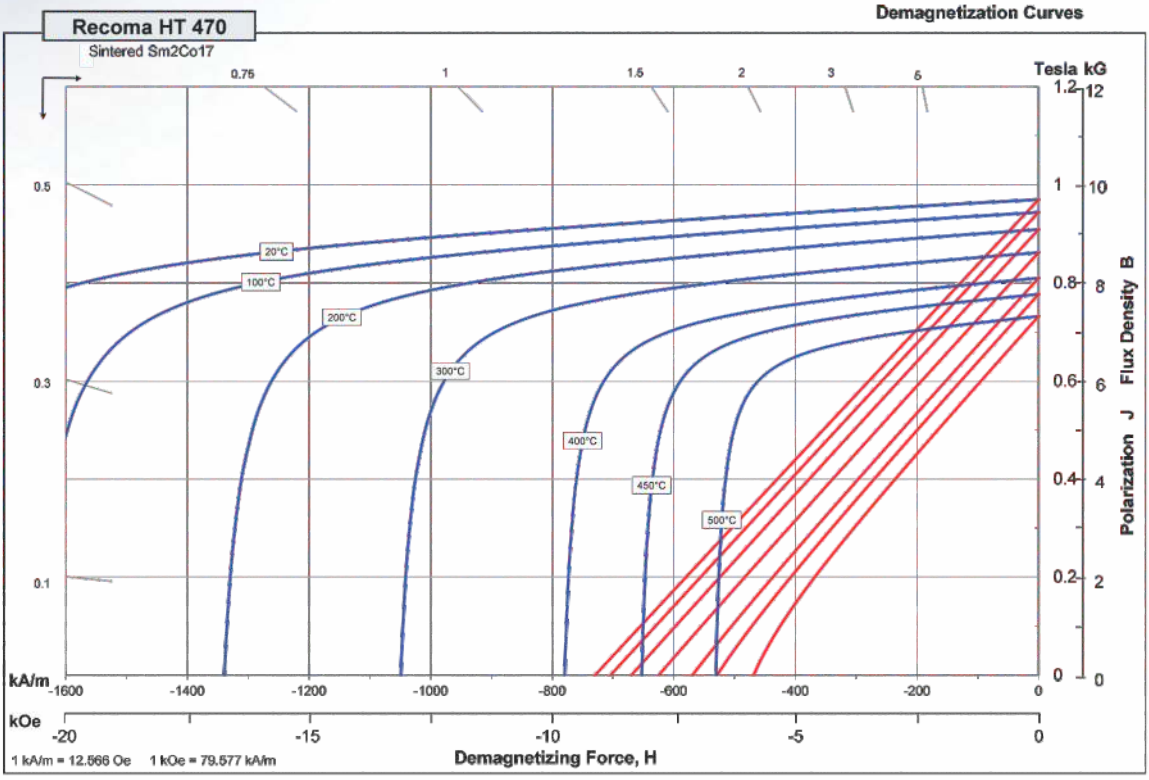
(1) Operating at a very low load line

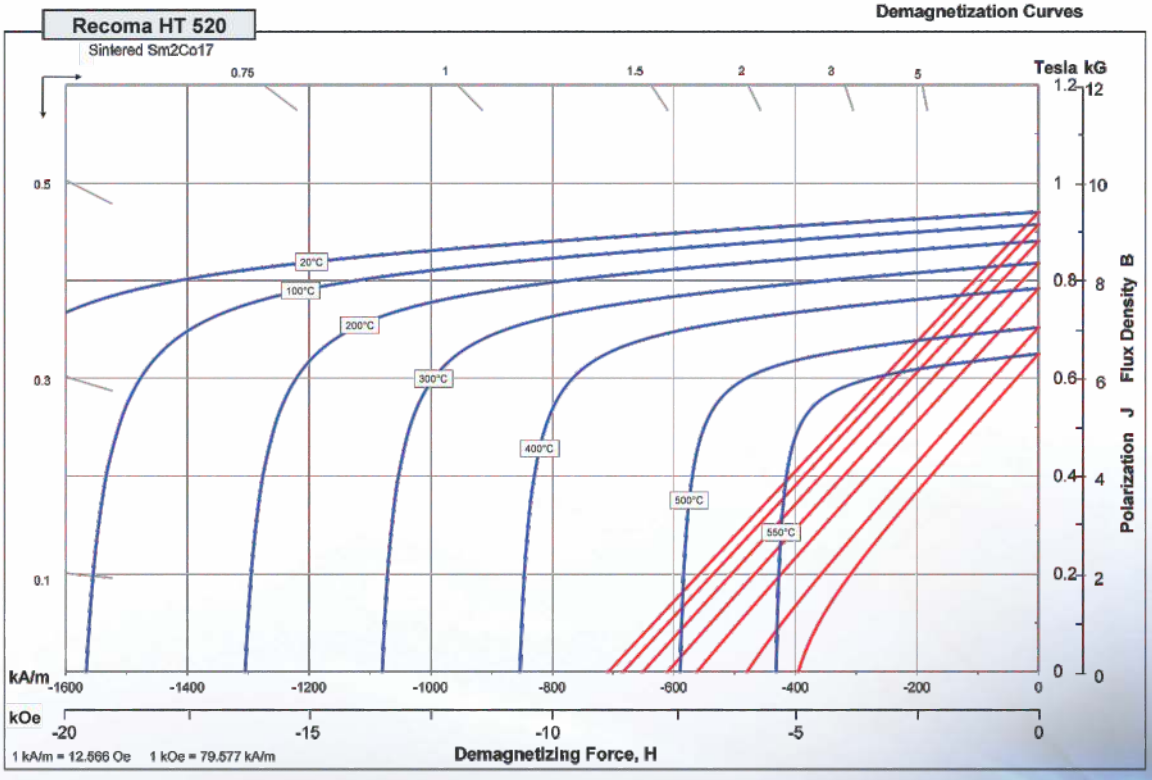
Demagnetizaton Curves





Demagnetizaton Curves





Corrosion Protection

Although SmCo type magnets show a good corrosion resistance at moderate temperatures, additional protection is necessary for applications operating above 400°C in oxidizing atmosphere. This protection can be provided by encapsulating the magnets or by a suitable type of coating.

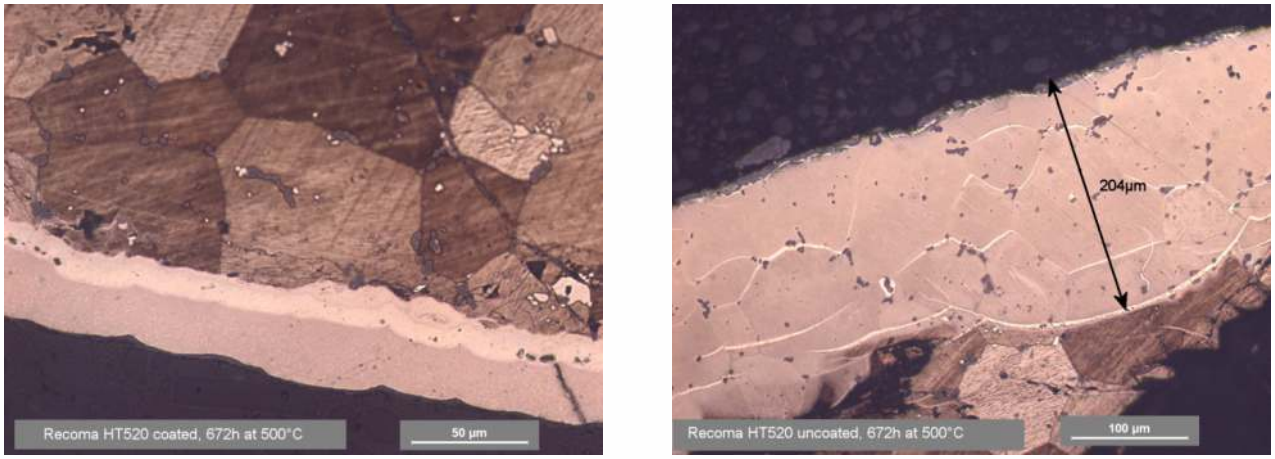


Figure 3

Comparison of a Recoma HT520 sample with a protective coating (left) and an uncoated sample (right). While the coated sample shows only a very thin layer of oxidized coating material, the uncoated material shows a thick layer of degraded magnet material.

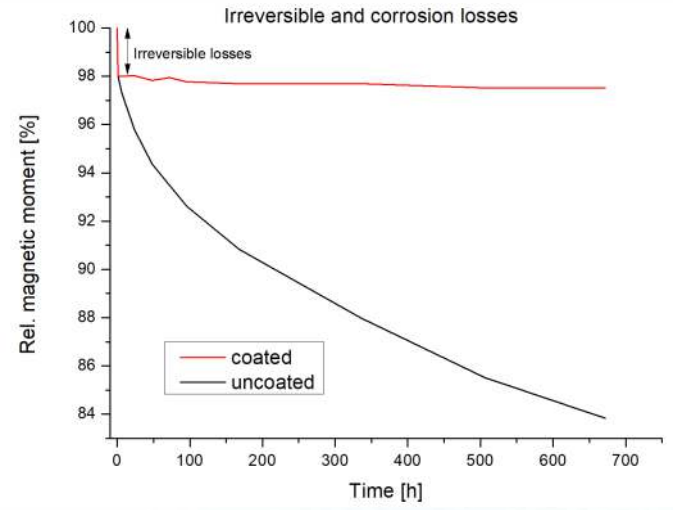


Figure 4

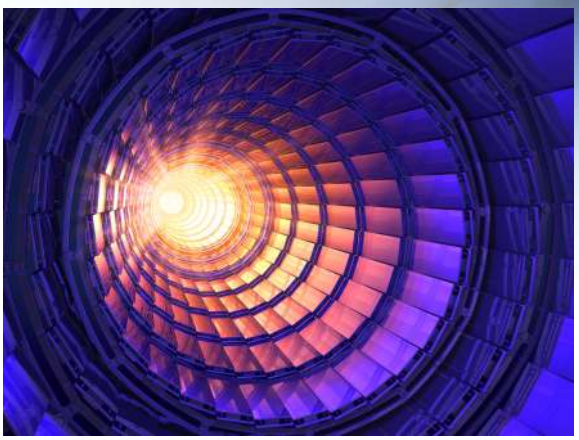
Rel. magnetic moment of HT520 cylinders Ø8.5 x 6mm after exposure to air at 500°C.

Applications

Permanent magnet drives
Ion thrusters
Sensors
Travelling wave tubes

Resistance Against Ionizing Radiation

The long time losses caused by ionizing radiation are closely related to the losses caused by temperature. Magnets with better high temperature performance will also better withstand ionizing radiation. Therefore Sm_2Co_{17}-type magnets are most often used for space applications or in in-vacuum applications of particle accelerators. Recoma HT magnets have an even better radiation resistance than standard SmCo magnets.



Qualification

Each material batch is qualified by measuring the irreversible losses at the nominal operating temperature.

Detailed Information

Designing applications for HT grades can be challenging, and depends on multiple factors such as the load line and environmental conditions. We strongly recommend contacting our application engineers, who can provide more detailed information and assistance in choosing the right Recoma HT grade, coatings and adhesives.

About Arnold Magnetic Technologies

Arnold Magnetic Technologies helps enable the efficient electrification of machines through advanced materials, including high-performance magnets and precision thin metals for motors and transformers that can run faster with higher efficiency and lower costs in smaller packages. Arnold's materials, engineered components and systems are proven in the most demanding aerospace & defense, motorsport, medical and industrial applications.

Learn more about Arnold's performance materials at **arnoldmagnetics.com**