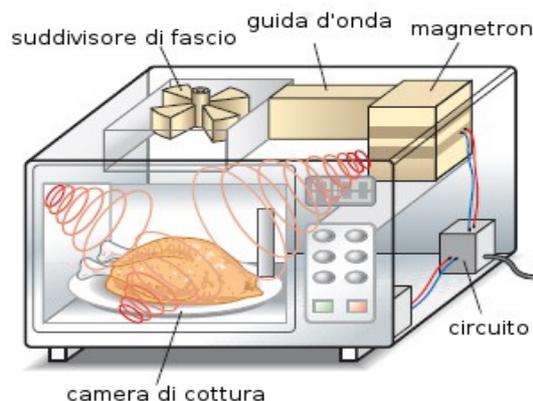


## EDUCATIONAL CARD: GADOLINIUM

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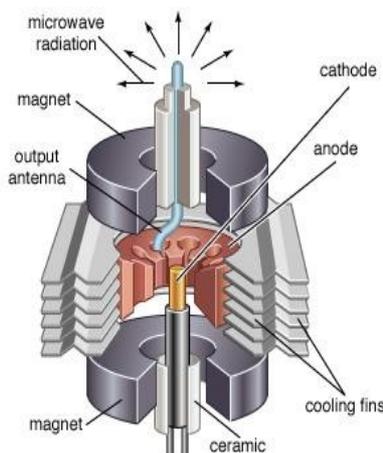
**The news:** The invention of the microwave oven has completely changed our life style, and as a lot of other inventions, it was discovered by chance in 1940 by the American engineer Percy Spencer, who was working for the Raytheon. The first microwave oven was built in 1947, it was bulky and cooled to water.

The high level Strategic Committee for raw materials of Bruxelles has declared that in Europe we use about 10-12 thousand tons of rare earth elements per year and the rate of recovery does not reach 1%



### The microwave oven:

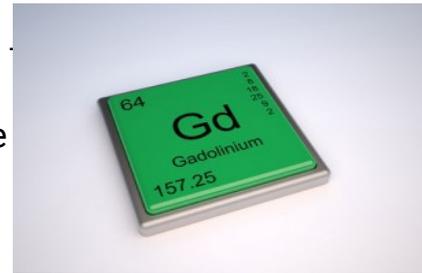
The key part of a microwave oven is the **magnetron**, an high-frequency generator which convert the electricity into electromagnetic waves. The Magnetron is an high power vacuum tube intended for the production of microwaves. This consist of an *anode*, a *cathode* and a **permanent magnet** which create two cross magnetic field, a magnetic field and an electric field. Food Heating and Cooking is made possible, above all, by the presence of the permanent magnet which is made of *alloys of Rare Earth as gadolinium yttrium garnet*. The magnetron generate an alternating electric field in the frequency of the microwaves, usually, with a power between 100W and 1KW which the wave guide send to the cooking chamber. Water, lipid and carbohydrates that constitute the food absorb the energy of the microwaves in a process called **heating dielectric**: the molecules are in general electric dipoles; so they are sensible at the electric alternating field, which, changing continuously his direction, induces the molecules to modify repeatedly their orientation on the basis of the frequency of the field. This movement generates heat through the force of friction with the close molecules and so it becomes a heating.



### Gadolinium

Gadolinium is a metal that is part of raw materials, atomic number 64, it has got a silvery white look and it is ductile and malleable. Such as the mineral gadolinite, the gadolinium has its name for the Finnish chemist and geologist Johan Gadolin. It is **strongly magnetic** at room temperature and is the only

metal not belonging to the transition metal group to exhibit magnetic properties. Gadolinium is used to produce **gadolinium yttrium garnet**, used in *microwave devices*; Gadolinium salts are also involved in producing **phosphors** for *color televisions*. Gadolinium is also used to produce *compact disks* and *memory devices for the computer*. It is used in *solid-fuel fuel cells* and also in the *medical field*.



### Recycling

For the countries is essential to increase the recycling of raw materials, then to invest in research extractive looking into replacing them with other materials. In Italy the consortium ReMedia is looking for the project E-waste Lab in collaboration with the Milan Polytechnic, to find new technologies able to recover the raw materials with enormous benefits both for the environmental and economic sectors. Processes, that are well suited to the mining of metals and raw materials from *WEEE (Waste from Electrical and Electronic Equipment)*, are those **idrometallurgicis** which consist of a set of a series of chemical and chemical-physics techniques of treatment in liquid phase of residues coming from industrial processing.

### The recovery

The West is also investing in the recovery of the rare earths through companies that use different methods of treatment depending on WEEE. One of these are the recovery. The two glasses are separated on TVs and monitors and simultaneous the hazardous fluorescent powders are aspirated, in the small home appliances (microwave oven, etc.) is used a special facility that allows the subdivision of component fractions (metals, memory cards, ...) and a similar treatment is also reserved for fluorescent lamps and tubes.



### Sources:

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