Interview: Dr. Emilio Olzi

Italian researchers foresee breakthroughs in superconductors

Emilio Olzi is the laboratory chief of the Institute for the Technology of Metallic Non-Traditional Materials at the National Research Center (CNR) in Milan, Italy. He was interviewed for EIR *by Agusto Provasoli.*

EIR: In less than a year, research on new superconducting material has taken enormous strides forward, which allows us to get a glimpse of still more extraordinary things to come in the near future. What is the current situation?

Olzi: In September 1986, Karl Muller of the IBM Zurich laboratories, in the course of his research on superconductors, found a ceramic material made of oxide of lanthanum, barium, and copper, which exhibited the phenomenon of superconductivity at about 40° Kelvin.

Immediately, a feverish race broke out in the scientific world to study this and similar materials. From February 1987 on, we have been witnessing—also in the daily press—daily updates on news related to a discovery of new materials which have critical temperatures (that is, the transition point between conductor and superconductor states) decidedly above the boiling point of liquid nitrogen (77°K).

The countries where these new materials are being most intensely studied are the United States, Japan, West Germany, England, China, and Italy—where, for the first time, our institute obtained and experimented with a whole series of these new materials.

In Italy, the CNR will finance a requisite "strategic project" which will involve 10 of its research institutes and a finalized project of more ample scope.

Many different procedures have been used so far, that vary in temperature, pressure, and atmosphere (more or less rich in oxygen). In every case, three oxides, appropriately mixed, are made to react with each other at high temperatures, in furnaces which control the composition of the atmosphere.

EIR: What advantages have come out of the use of these new materials?

Olzi: The importance of the discovery of these new materials can be better understood by contrasting some of their properties with the "old" superconducting metals.

There are three essential characteristics of a superconducting material: critical temperature, critical magnetic field, and critical current density.

As for temperature, it must be noted that the new materials work at an absolute temperature of about 93°K as opposed to the 23°K of the previous best metallic superconductors. In practice, this means that substantial savings can be made in the future, whether in the costs of the cryogenic plant or in operating costs. In fact, it will be sufficient to use liquid nitrogen as a coolant which costs a good 15 times less than liquid helium, the refrigerant used today.

The "critical magnetic field" is one beyond which a superconductor immersed in it, will cease to be such. In other words, using a superconductor material, it is not possible to construct a magnet that generates a magnetic field stronger that the critical field; rather, the magnetic field obtainable is usually substantially less than the critical field.

Even lacking experimental evidence with regard to the new materials, one can compare the theoretical values of the old and the new for the critical magnetic field at absolute zero: 40 tesla for the old superconductors; 300 tesla for the new.

The third characteristic, critical current density, is the only one in which until today, the old materials perform better: between 10/7 and 10/9 Amps/cm^3 as opposed to values of about 10/7 for the new materials.

It's a question of how much current can circulate in a wire that has a cross section of one cm^3. While the first two characteristics, critical temperature and magnetic field, depend uniquely in the type of material, the critical current density also depends heavily on the technology for preparation of the material. Therefore, we can be optimistic that these low values can soon be improved upon.

Another important aspect is the workability of these new materials; that is, how easy it is to manufacture particular objects (wires, tapes, bobbins, etc.) necessary for practical use.

The current researchers are primarily those who until a few months ago only knew how to handle metallic materials (the old superconductors) and thus they have been ill at ease working with these new ceramic-type materials.

Without any doubt, we will witness, in the next couple of years, an enormous growth in the technologies relative to the preparation and the working of these new materials.

EIR: The use of superconductors at the temperature of liquid nitrogen has opened up the possibility of interesting applications of such technologies in large sectors of the economy. What do you see for the future?

Olzi: The starting point for any such discussion is necessarily the current superconductor technology using the old materials, cooled to the temperature of liquid helium.

We have already mentioned that as soon as we can apply the new materials, we will definitely make considerable savings. This would be the case, for example, with NMR [nuclear magnetic resonance] technologies—both those used for chemical and biochemical research, and those used in diagnostic medicine. In fact they use a powerful magnetic field obtained by using superconducting materials.

Another example is MHD [magneto-hydrodynamic] technology for magnetic fluid dynamic conversion of energy—whose use is foreseen to expand greatly in the near future. In MHD they also use a powerful magnet, which can be built only with superconducting materials.

The field is all applied directly to the burning gases of a traditional fossil-fuel generating plant (oil, methane, coal), which allows a current to be drawn directly from the ionized plasma which is the burning gas itself. This results in a substantial increase in efficiency in the production of electric energy, not to mention a reduction in pollution caused by the emission of dust particles.

In the field of nuclear fusion, today still at the experimental stage, new and more powerful magnets can be made with the new materials, under conditions that would be prohibitive for the old, and could decisively improve the magnetic confinement of plasmas.

As for future applications, the only limit is your imagination. . . . I think these materials will serve to change the world. The most easily imagined applications are in the electro-technical field: new electric motors which will be relatively small and powerful; electric, magnetically levitated trains with speeds of about 500 km/hr.; and new forms of energy transport.