Production of ribbon quenched samples using an arc furnace

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We describe a new device to produce ribbons of disordered metals by ultrarapid quenching combining an arc furnace with a rotating cylinder. The characterization of samples of disordered $La_{70}Cu_{30}$ and $La_{76}Au_{24}$ prepared using this method shows good agreement with those obtained by other authors for the same alloys.

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We have built a device for preparing metallic ribbons by ultrarapid quenching. In this system we combine the advantages of the arc furnace[1] with the rotating cylinder technique.[2]

The main features of the apparatus can be seen in Fig. 1. The device has two chambers: the upper one is the arc furnace itself, with a removable water-cooled copper anode that allows the furnace to be used in a conventional way or as described below. The rotating copper cylinder is located in the lower chamber. The two chambers are connected by an orifice, on top of which the sample to be splat cooled is placed for heating. The two chambers connected only by the orifice can be pumped separately with the sample in place and filled with a chosen gas.

The apparatus was used to make $La_{70}Cu_{30}$ and $La_{76}Au_{24}$ disordered alloys. The alloy was prepared by mixing the components in a conventional arc furnace obtaining pellets from 0.1 to 0.005 g weight. The pellet was then placed on the orifice of the water-cooled copper anode. The sample acts as a plug so that an arbitrary pressure difference can be maintained between the upper and the lower chambers. After the pressure difference has been established, the cylinder is rotated by means of the air turbine up to the chosen speed, the material is melted and sucked through the orifice and cooled on the copper cylinder.

The best results were obtained when the material was overheated and the pressure differences were over 350 mm Hg.

The diameter of the rotating copper cylinder is 9 cm. The distance between the cylinder and the orifice is 0.15 cm. The rotating speed used in the sample preparation varied between 6000 and 9000 rpm, and the orifice diameter is 0.05 cm.

The ribbons produced have a fairly uniform thickness of about 15 μm, and a width of about 1 mm.

The ratio of mass per unit length was of order of 1 mg/cm. Ribbons up to 30 cm long have been obtained.

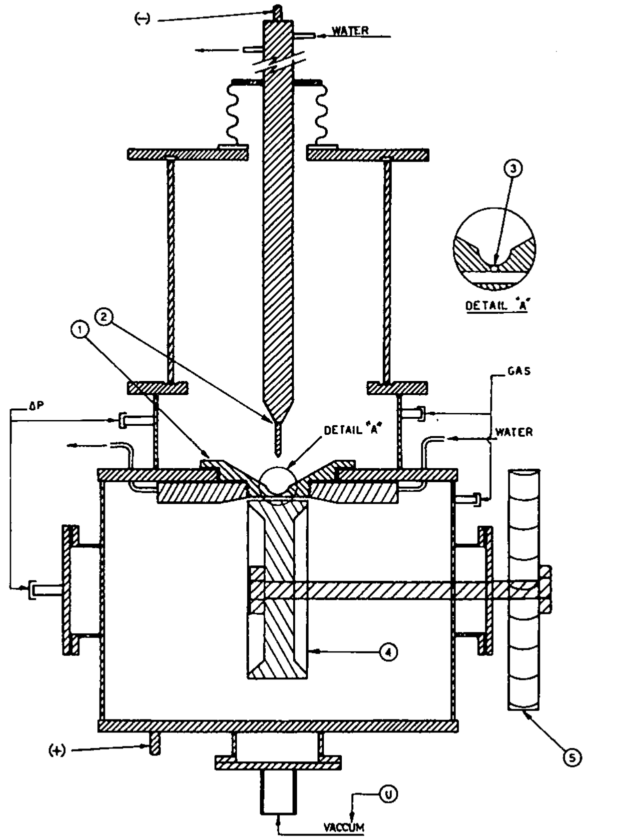

FIG. 1. (1)—Water-cooled copper anode, (2)—cathode, (3)—orifice, (4)—copper cylinder, (5)—air turbine.

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The time to melt and splat the material is estimated to be 1 s.

To characterize the state of disorder in these samples we have used measurements of the superconductive transition by means of the dc resistance and ac susceptibility techniques. The results were compared to those obtained by other authors for splat cooled $La_{76}Au_{24}$[3] and to our own results for splat-cooled $La_{70}Cu_{30}$ samples.[4] The superconductive transition width obtained in different samples varied between 150 and 15 mK, indicating the existence of a single disordered phase.[4]

The critical temperatures and the slopes of the critical field agree with the previously reported values.[3,4]

One of the main advantages of this system is that it allows the preparation of ribbons using small amounts of material preserving the purity. On the other hand, by changing the typical parameters (diaphragm diameter, cylinder speed, pressure difference) it is possible to prepare ribbons of different materials in metastable states. In particular ribbons of Zirconium have been produced.

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