

CONCLUDING REMARKS

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Until rather recently a conference on metastable phases would have been concerned with non-equilibrium phases obtained by quenching from the solid state. The large majority of the papers presented at the present conference dealt with more unusual phases obtained by either vapor or liquid quenching, and the abundance of new results discussed is indicative of the great interest physicists and metallurgists attach to this relatively new subject. The diversity of approaches described in the papers presented underlines both the theoretical and the practical aspects of these unusual metastable phases.

The most widely studied metastable alloys quenched from the liquid state appear to be the amorphous ones and the supersaturated solid solutions, with less emphasis on metastable crystalline intermediate phases. The problem of differentiating between amorphous and microcrystalline solids has raised many arguments among solid state physicists. This fundamental question was discussed at this conference and the papers presented on this subject and published as part of the proceedings will probably become a classic on this still controversial subject. The electrical and magnetic properties of amorphous alloys were briefly reviewed. The mechanical properties of amorphous metallic alloys were also presented, and this, perhaps, constitutes the first exhaustive investigation of this still practically unexplored field.

A large number of papers were devoted to supersaturated solid solutions obtained by liquid quenching, the majority of which dealt with aluminum-base alloys with transition elements. The large increase in strength (or in microhardness) observed especially with iron has created a widespread interest in these alloys. Techniques were described by which the small flakes of quenched alloys could be consolidated into relatively large ingots, hence opening the way to engineering applications of these metastable alloys. In this connection it was also pointed out that the ultra-high rates of cooling of the order of 10^6 to 10^8 °C/sec are not always necessary to synthesize interesting phases and more attention should be given to the still unexplored range of cooling rates between those obtained by the present foundry practices and the ultimate rates which, so far, belong to the research laboratories. It should be pointed out, however, that several papers described new and very ingenious techniques for quenching liquid alloys into larger specimens such as continuous strips

or wires, or large quantities of flakes.

Vapor quenching (high vacuum evaporation or sputtering) has been used for sometime for producing metastable amorphous phases and even amorphous elements when the substrate is kept at very low temperature. Recent results presented at this conference show that by coevaporating two elements of different atomic masses and locating the evaporators and the substrates in such a manner that the two atomic species collide before hitting the targets, it is possible to synthesize new metastable crystalline intermediate phases. This ingenious new technique is likely to lead to a large number of new phases which cannot be obtained by any other method.

I would like to conclude these remarks with a few thoughts about what could be attempted next to extend this field beyond its present state of the art. It would obviously be interesting to push the rates of cooling from the liquid state beyond the present limit of the order of 10^6 to 10^8 °C/sec. It is improbable that a factor of 10 will bring up many new results. The next goal should be in the range of 10^{10} to 10^{13} °C/sec. If this upper limit could be reached it is probable that all alloys would be amorphous. I would not venture to suggest any solution to this problem, but I am reluctant to say that this is an impossible goal to achieve.

A different approach to the problem of trying to influence the transition from the liquid to the solid state may be to consider, instead of a large derivative of the temperature with respect to time, a large derivative of the pressure with respect to time. The melting point of most alloys is depressed by pressure, and if the pressure could be released in times of the order of one millisecond or less, unexpected solid state phases might be obtained. The experimental difficulties involved in achieving very high rates of pressure release are obvious, but such difficulties are generally surmounted by the inexhaustible ingenuity of our younger experimental physicists. It is hoped that at the next International Conference papers dealing with metastable phases obtained by "Pressure Quenching" will be presented.

These concluding remarks should end with thanks to the organizing Committee of this Conference. It is my feeling, however, and I hope that the other members of the Committee, and all the participants will agree with me, that recognition for this most successful conference should be given to Professor Pač, whose far reaching vision motivated him in bringing us all here to exchange ideas and experiences, thus giving further impetus to a new approach to the study of alloy phases.