New intermetallic compounds through solid state synthesis

There are different classifications of chemical systems. One of them distinguishes between intermetallic compounds (consisting of only metallic elements) and others in which there is at least one non-metallic element present. In the latter, a very large group, we find the important family of metal oxides, which are most often obtained by the solid-state reaction method. Intermetallic materials, in contrast, are often produced by utilizing an arc-melting method. This method cannot be used, however, for metals that easily evaporate, such as magnesium, cadmium, and ytterbium. It is difficult, if possible at all, to melt and react two metals that differ significantly in their melting and boiling points, e.g. samarium and iridium, or when the melted materials tend to crack on cooling, which sometimes happens in an explosive manner. The latter group includes, among others, boron and some of its compounds with metals.

In the project, we will use the solid-state reaction method to obtain new intermetallic compounds, the synthesis of which does not succeed through melting the constituents together in an electric arc. Our preliminary studies show the usefulness of the method and has allowed for the synthesis of new iridium-based compounds in the Laves phase family (i.e. $REIr_2$; RE = a rare earth element) and the very difficult to obtain binary intermetallic compounds $REIr_3$ and RE_2Ir_7. We will also search for new ternary boride compounds using this method in order to compensate for the often explosive failure of the arc melting method to synthesize them. In particular, we will investigate the occurrence of such compounds in the Nb-T-B and Ta-T-B systems, where T is a metal from groups 10 and 11. Such compounds have not been described in the literature and are not found in available material databases. We have confirmed the effectiveness of the solid-state reaction method, as well as the proposed strategy for searching for new compounds, by describing the crystal structure and superconducting properties of three intermetallic materials: $Mg_{10}Ir_{19}B_{16}$, $NbIr_2B_2$ and $TaIr_2B_2$.

The arc-melting method

The solid-state method