

## Microstructure and Mechanical Properties of Hardmaterials

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Hardmaterials such as cemented carbides with or without coated layer, cermets, ceramics and diamond or c-BN high pressure sintered compact are used for cutting tools, wear-resistant parts, rock drilling bits and/or high pressure vessels. These hardmaterials contain not only hard phase, but also second constituent as the element for forming ductile phase and/or sintering aid, and the mechanical properties of each material depend on (1) the amount of the second constituent as well as (2) the grain size of the hard phase. The hardness of each material mainly depends on these two factors.

The fracture strength, however, largely depends on other microstructural factors as well as the above two factors. For all hardmaterials, the fracture strength is considerably affected by (3) the size of microstructural defect which acts as the fracture source. In cemented carbides, the following factors which are generated mainly due to the addition of the second constituent are also important; (4) the variation of the carbon content in the normal phase region free from  $\eta$ -phase and graphite phase, (5) the precipitation of  $\text{Co}_3\text{W}$  during heating at about  $800^\circ\text{C}$ , (6) the domain size of binder phase, and (7) the formation of  $\beta$ -free layer or Co-rich layer near the surface of sintered compacts. For cemented carbides coated with thin hard substance, the important factors are as follows; (8) the kind of coated substance, (9) the formation of  $\eta$ -phase layer at the interface between coated layer and substrate, (10) the type of residual stress (tension or compression) in the coated layer which depends on the kind of coating method (CVD or PVD), and (11) the properties of the substrate, and (12) the combination, coherency and periodicity of multi-layers.

In the lecture, the details of these factors and their effect on the strength will be explained.