

## Manufacturing of Nano TiC/SiC<sub>w</sub>/Si<sub>3</sub>N<sub>4</sub> Reinforced Ceramic Composite Cutting Tool Material and its Characteristics

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Nowadays, in machine–building industry, various hardened materials such as hard steel alloy and nickel–base refractory alloy are widely used to enhance productivity and improve the quality of product. Consequently, traditional tools such as high speed tool steel and cemented carbide can't satisfy technical demands of cutting work. Especially, tungsten and cobalt that is the main raw material of cemented carbide are drained gradually in the world. For this reason, it becomes one of tendencies to develop and use a new tool material which is rich and has a good characteristic of cutting in the field of cutting tool making. Reinforced ceramic composite is a new tool material that is developed recently and used in production of cutting tools aggressively. Reinforced ceramic composite can be classified into Al<sub>2</sub>O<sub>3</sub> based and Si<sub>3</sub>N<sub>4</sub> based and it isn't widely used in practice because of low mechanical characteristics.

In this paper, we described the making method of Nano TiC/SiC<sub>w</sub>/Si<sub>3</sub>N<sub>4</sub> reinforced ceramic composite cutting tool material in hot press sintering process and its improved several mechanical characteristics.

First, Nano powders of TiC and SiC<sub>w</sub>, micro Si<sub>3</sub>N<sub>4</sub> powder, Y<sub>2</sub>O<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub> powders as sintering agent are dried in drier respectively.

And we weighed the powers (Nano TiC powder, micro Si<sub>3</sub>N<sub>4</sub> powder, sintering agent powder) defined at the fixed rate and mixed with distilled water in Al<sub>2</sub>O<sub>3</sub> ceramic ball mill.

The pH value of mixed suspension is kept as in 10.5~11 using the 15% ammonia water. We added the polymethacryl ammonia (PMAA–NH<sub>4</sub>) which is 0.6% of solid phase in suspension and agitate well, ball mill for 12h. On the other hand, weigh the dried SiC<sub>w</sub> powder in a certain ratio and agitate with distilled water, keep the pH 10.0~10.5 using the ammonia water as mentioned above. With the “XQ–750” type of ultrasonic unit, treated it for 20min and obtain the SiC<sub>w</sub> suspension which SiC<sub>w</sub> is dispersed homogenously.

Next, we agitated this suspension mixed SiC<sub>w</sub> powder with made suspension mixed Si<sub>3</sub>N<sub>4</sub> powder. And again agitate well in ball mill for 12h, make the suspension of Nano TiC/SiC<sub>w</sub>/Si<sub>3</sub>N<sub>4</sub> ceramic composite powder and mixed homogenously. And vacuum filters made suspension of ceramic composite powder and dry it at 100~150°C, therefore, made the Nano TiC/SiC<sub>w</sub>/Si<sub>3</sub>N<sub>4</sub> ceramic composite powder, mixed homogenously.

We weigh Nano TiC/SiC<sub>w</sub>/Si<sub>3</sub>N<sub>4</sub> ceramic composite powder mixed homogenously and charge in graphite template. And install it in vertical vacuum hot press sintering furnace and sintered according to the defined sintering mode.

Here, we analyzed X–ray diffraction of hot press sintered Nano TiC/SiC<sub>w</sub>/Si<sub>3</sub>N<sub>4</sub> ceramic composite according to sintering mode mentioned above using RAX–10A type X–ray diffraction.

By doing so, we explained the influence of phase composition which affects the presence of chemical reaction between elements and mechanical characteristics of ceramic composite.

From X–ray diffraction result, we can know that no contents react in HP process of 1 800°C (sintering temperature) and 1~2h (sintering keep time). Especially, Nano TiC particles which have strong activities are stabilized comparatively and α–Si<sub>3</sub>N<sub>4</sub> phase in resource is phase transformed in β–Si<sub>3</sub>N<sub>4</sub> phase all.

The bend strength and fracture toughness of Nano TiC/SiC<sub>w</sub>/Si<sub>3</sub>N<sub>4</sub> ceramic composite tools are raised to ~1 000MPa, ~10 MPa·m<sup>-1/2</sup> respectively and higher than various kinds of composite ceramic.

Nano TiC/SiC<sub>w</sub>/Si<sub>3</sub>N<sub>4</sub> ceramic composite tool is fit to roughing and semi–finishing cutting with shock and Nano Si<sub>3</sub>N<sub>4</sub> ceramic composite tool is fit to finishing cutting of high hardness blanks.