

Nanocomposites and nanomaterials.

The effect of a small amount SiO₂ on sintering kinetics of tetragonal zirconia nanopowders.

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Ceramics based on tetragonal zirconia nanopowders (3Y-TZP) has excellent mechanical properties, such as high fracture toughness, strength, hardness et al. This ceramic material has become an important structural ceramics. It used in optical fiber connectors, grinding media, precision parts. It also applied in orthopedic surgery because of good biocompatibility. The mechanical properties of 3Y-TZP nanopowders strongly depend on the microstructure which can be controlled by applying the sintering-acceleration effect of additives and by changing nanopowders obtaining conditions [1].

To develop a high-performance nanopowders, it is necessary to clarify the effect of various additives on the sintering mechanism of 3Y-TZP.

In this paper we investigated sintering behavior of 3Y-TZP with and without a small amount of SiO₂ to clarify the effect of SiO₂ addition on the initial sintering stage. The initial sintering stage was studied by a constant rate of heating (CRH) method at the different heating rates [2].

We found that 0.2 wt % SiO₂ additive in depending from methods of dopant addition have different effects on sintering kinetics and mass transfer mechanisms of zirconia nanopowders as shown in Table 1.

Table 1. The order of diffusion mechanism and activation energies of sintering.

| Nanopowders | n | Q (kJ/mol) |
|--|-----|------------|
| 3Y-TZP (DIPE) co-precipitation | 1/2 | 667 |
| 3Y-TZP-0.2 wt % SiO ₂ co-precipitation | 1/3 | 830 |
| 3Y-TZP-0.2 wt % SiO ₂ powder mixing, milling for 4h | 1/2 | 680 |

1. Matsui K., Sintering Kinetics at Constant Rates of Heating: Mechanism of Silica-Enhanced Sintering of Fine Zirconia Powder // J. Am. Ceram. Soc. - 91 [8]. - 2534–2539.- 2008.

2. Matsui K, Yamakawa T, Uehar M, N Enomoto, Hojo J: Sintering mechanism of fine zirconia powders with alumina added by powder mixing and chemical processes// J Mater Sci. – [43] - 2745–275.-2008.