Metallic Nanostructures Controlled by Dewetting Thin Film on Patterned Ceramic surface

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Solid oxide fuel cells (SOFCs) are promising energy conversion devices because of the high efficiency. In conventional electrodes, nanostructures are randomly placed and the paths of electrons, ions, gases and their triple phase boundaries (TPBs) where the species are reacted each other are randomly placed. Therefore, the microstructures of conventional electrodes are not optimum. In this study, a method of dewetting thin metallic film on ceramic surface is developed to obtain efficient TPBs of metal, ceramic and pore. Patterned ceramics Dewetting thin metallic film on plane surface had been researched.[1-3] However, plane surface cannot provide enough area to form TPBs. We researched dewetting thin metallic film on patterned ceramic surface in order to obtain more TPBs.

Figure 1 shows the procedure of dewetting thin film on patterned ceramic surface. At first, the Ni is deposited on the yttria-stabilized zirconia(YSZ) pattern by sputtering. Then, the Ni is sintered and agglutinated. As a result, Ni is dewetted and nanoparticles are formed, which leads to the formation of TPBs on the walls of ceramic pillars.

The YSZ microstructures were fabricated by an excimer laser as shown in Figs. a1 - a4. The Ni with the thickness of 500 nm was sputtered on the surface of YSZ (Figs. b1 - b4). After sputtering, the samples were sintered at 800˚C for 120 min in 3% hydrogen and nitrogen with atmospheric pressure to prevent the oxidation of Ni. The Ni agglutination was confirmed and TPB was fabricated on the walls of YSZ pillars (Figs. c2 - c4). However, when the trenches between YSZ pillars was narrower than 1 μm, during sintering, the Ni at the bottom of YSZ pillars rose up to the top surface of YSZ and agglutinated to a thin film as shown in Fig. c1. In this case, TPB was not fabricated on the walls of YSZ pillars. Also, when the pillars were higher than 5 μm, gaps of TPBs appeared (Fig. c4).

We successfully dewetted thin Ni film on patterned YSZ surface. Also, we confirmed that, to obtain more TPBs, the trenches between YSZ pillars should be wider than 1 μm and YSZ pillars should be lower than 5 μm.

[1] H. Kishimoto *et al.*, *J. Power Sources.* 199 (2012) 174
[2] T. Ryll *et al.*, *Adv. Funct. Mater.* 21 (2011) 565
[3] J. Petersena, S. Mayr, *J. Appl. Phys.* 103 (2008) 023520

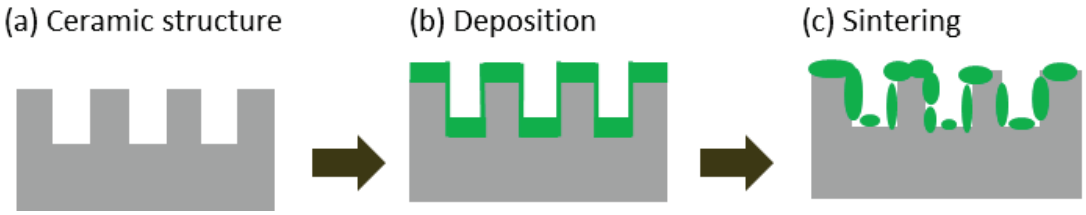

Figure 1: Schematic of processes for dewetting thin metallic film on patterned ceramic surface.

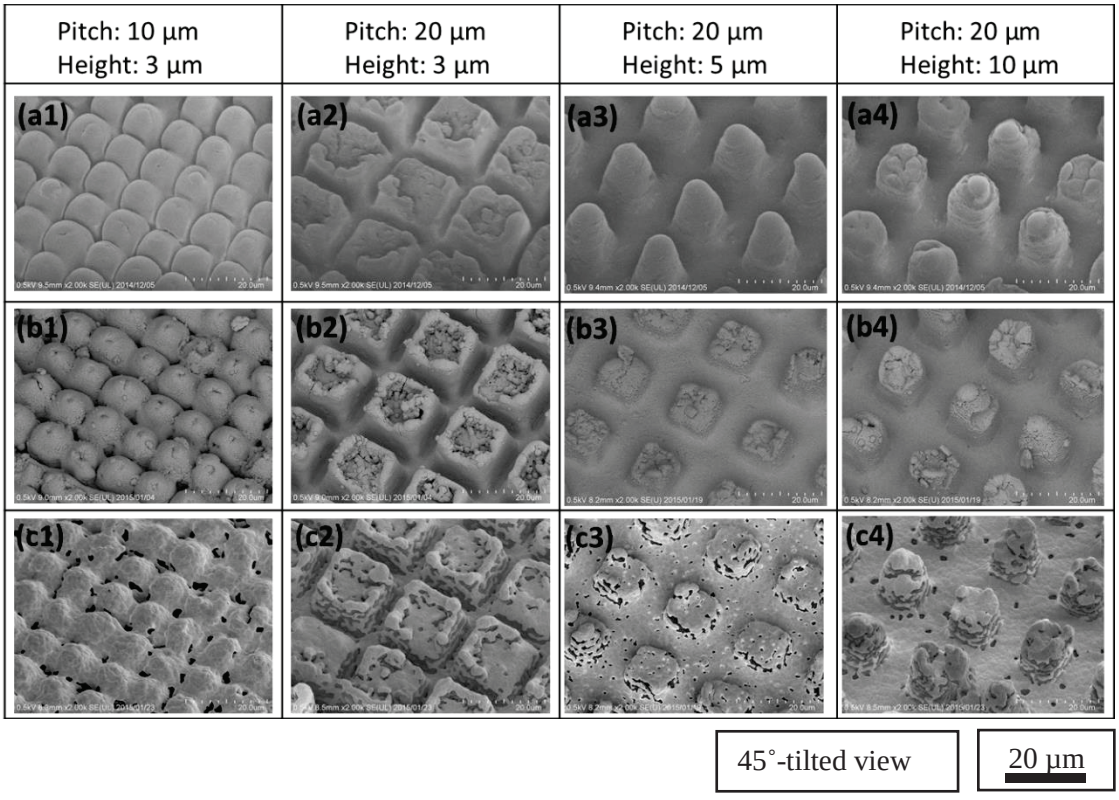

Figure 2: SEM images of each process for dewetting thin Ni film on patterned YSZ surface: a1 - a4 show the macro-structures of YSZ surface. b1 - b4 show the YSZ surface after Ni sputtering. c1 - c4 show the YSZ surface after sintering.