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Applications of SEM and Con-focal Laser Microscopy in Developments of Macro-Porous Materials Produced by Sintering

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Our group has developed many kinds of new macro-porous materials by applying a hot isostatic process (HIP) [1-3] and pulsed electric current sintering (PECS) [3,4]. In order to develop macro-porous materials, evaluation of microstructure is important to consider production parameters and properties of porous materials.

A scanning electro microscope (SEM) is used to observe microstructure of macro-porous materials. For example, bonding parts between grains are important for mechanical properties of porous materials. Figure 1 shows the SEM images of bonding parts of SiC grains in a grinding wheel with a vitrified bonding agent. Cracks located in the bonding part disappear by HIPing. Applications of HIP for this materials promise to increase mechanical strength of porous materials [1,2].

A con-focal laser microscope has also great potentials for observing microstructure of porous materials. The laser microscope enables to observe microstructure with relatively high resolution and large focus depth in large area. Since the laser microscope is available in air and requires no particular treatment to sample surfaces, it leads to reduce an operation time compared with SEM. Figure 2 shows the comparison of an SEM image and con-focal laser microscopic one of porous Bi-system superconducting oxides. The laser microscope provides excellent images to understand microstructure of porous materials.

Furthermore the con-focal laser microscope provides surface profiles, which is useful for studying surface treatments of porous materials. For example, to refresh a surface of grinding wheels, a dressing is applied to a grinding wheel when its grindability degrades during machining. Dressing is one of key processes to increase efficiency of precise grinding advanced ceramics and semiconductors. Our group has developed a new dressing technique with laser, which realizes in-process dressing [5, 6]. Figure 3 shows the surface image and surface profiles of a porous cast-iron matrix diamond grinding wheel treated by an Nd:YAG laser-dressing technique. Applying the laser dressing, fresh diamond grains appear on the grinding wheel surface. Surface roughness, which influences grinding performance, can be evaluated quantitatively and simultaneously when the surface morphology is observed.

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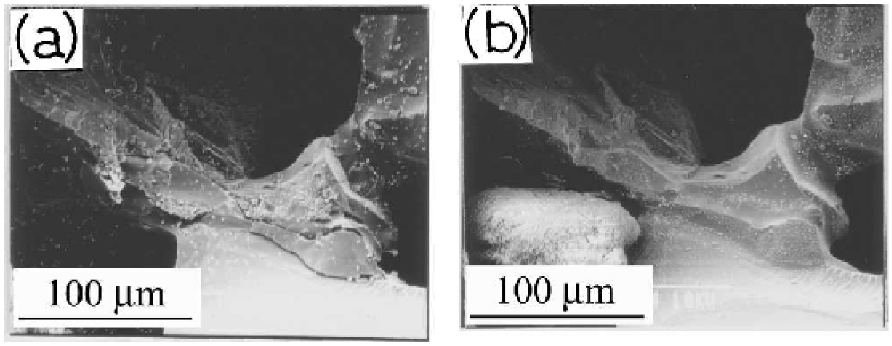

Fig. 1 SEM images of bridges of vitrified bond and SiC grains in grinding wheels sintered in a conventional sintering process (a) and by a hot isostatic pressing method (b).

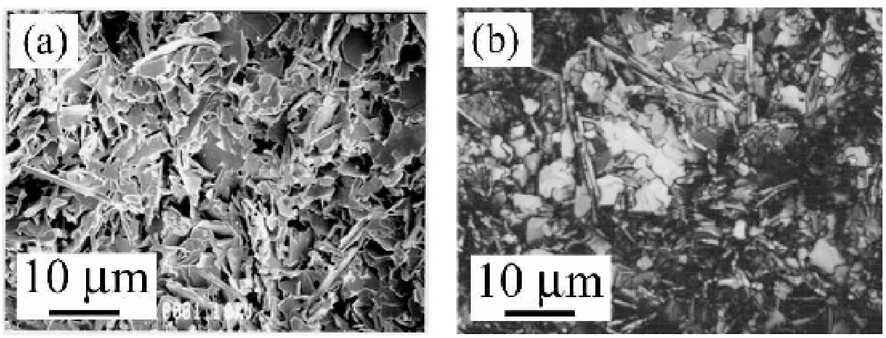

Fig. 2 Microstructures of a Bi-phase porous superconducting material in an SEM image (a) and optical image taken by a con-focal laser microscope (b).

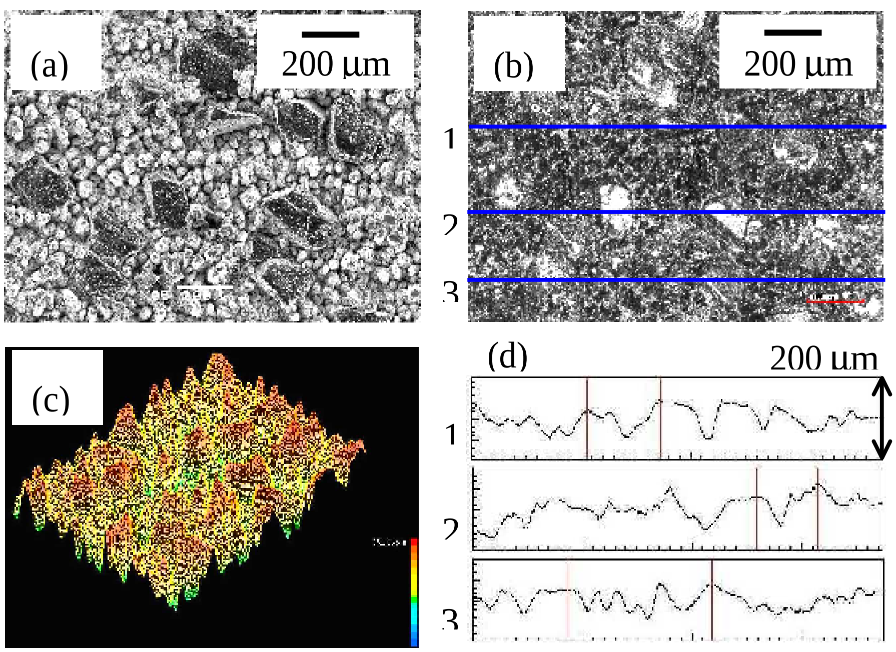

Fig. 3 Surface of a laser-dressed porous cast-iron bonded diamond grinding wheel. (a) is an SEM image. (b), (c), and (d) are an optical image, 3D, and line profiles given by a con-focal laser microscope, respectively. Lines 1, 2, and 3 in (b) correspond to profile lines 1, 2, and 3 in (d).

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