Synthesis of metal-substituted lambda-Ti_3O_5 by arc melting method

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The trititanium pentoxide (Ti_3O_5) has a stable β-phase and a meta-stable λ-phase at room temperature.[1] λ-Ti_3O_5 (Fig. 1a) was first discovered in our group in 2010. External stimulations, such as pressure, induce the λ-phase to turn into the β-phase.[2] When high-pressure induces the λ-phase to β-phase, heat-release occurs. Also, heating induces the β-phase to return to the λ-phase by heat absorption. Thus, the present material is vigorously studied as heat-storage material.[2] Nanometer-size effect is the key to stabilize Ti_3O_5 as the λ-phase.[3] Several synthesis methods for λ-Ti_3O_5, as well as λ-Ti_3O_5 with metal doping, have been reported in recent years.[4-7] In 2020, we reported synthesis of metal-doped λ-Ti_3O_5 by arc melting method.[4]

In the present work, we synthesized Al-doped λ-Ti_3O_5 with the arc melting method. Firstly, Ti powder, rutile TiO_2 powder, and Al_2O_3 powder are mixed. Secondly, the mixture of the powder is pressed to form a bulk. Finally, the pellet is put in a low-pressure Ar atmosphere on a cupper stage, where the arc current is applied to heat the pellet. The obtained sample was a hemisphere with a radius of ca. 5 mm(Fig. 1b). From the X-ray fluorescent spectroscopy(XRF) measurement, the substitution ratio was determined to be [Al]/([Ti] + [Al]) = 2.84 %. The sample was ground into powder, and scanning electron microscopy(SEM) and X-ray diffractometer(XRD) measurements were conducted. The SEM image is in Fig. 1c. From the Rietveld analysis of the XRD pattern, the obtained sample was composed of 91.5 % λ-phase and 8.5 % β-phase(Fig. 1d). We succeeded in synthesizing Al-doped λ-Ti_3O_5 with arc melting method.

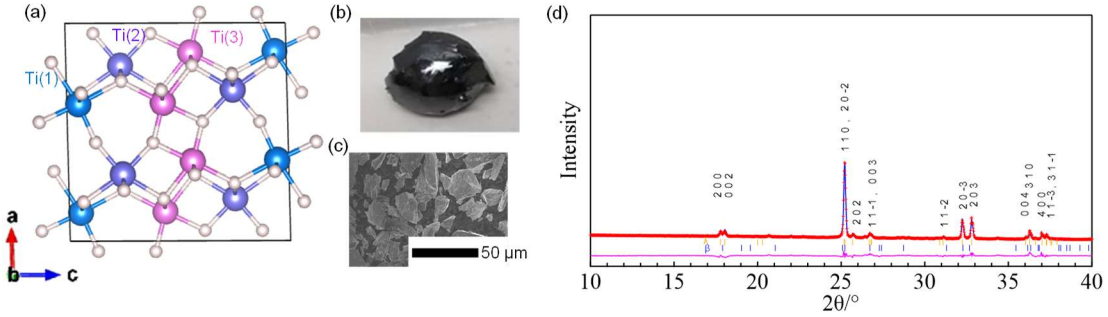

Figure 1. (a) Crystal structure of λ-Ti_3O_5. (b) Photograph, (c) SEM image, and (d) XRD pattern with Rietveld analysis of Al-doped λ-Ti_3O_5. The values represent the lattice plane index of λ-Ti_3O_5.

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