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Pressure-induced amorphization in vanadium pentaoxide

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Introduction

In recent years vanadium pentaoxide has attracted considerable attention due to interesting semiconducting properties. Amorphous V_2O_5 films find applications in gas and moisture sensing and in optoelectronic switching devices. V_2O_5 has been extensively studies at high pressure and high temperature for possible structural phase transitions [1-4]. The ambient pressure phase has layered orthorhombic structure with corner and edge sharing VO_5 square pyramids. On the other hand, high pressure phase consists of a network of VO_6 octahedra. In the present work we have carried out in-situ x-ray diffraction on V_2O_5 using synchrotron radiation at Photon Factory to explore the possibility of obtaining an amorphous phase at high pressure.

Results and discussion

V_2O_5 powder sample was loaded in a diamond-anvil cell (DAC) along with a small gold foil. The x-ray diffraction measurements were made using synchrotron radiation (λ = 0.4131(2) Å) from the beam-line NE1 at Photon Factory, KEK. The pressure in the DAC was estimated from the equation of state of gold. An image plate was used as the detector. The 2-D image plate data was integrated to convert it to 1-D intensity versus 2θ data.

Figure 1 shows the diffraction patterns as a function of scattering angle 2θ at different pressures. Above 7 GPa new lines appear in the pattern which are consistent with the reported high-pressure monoclinic phase [2]. The two phases are found to coexist between 7 and 10 GPa. One can also see that the intensities of diffraction peaks reduce when pressure is increased further. This suggests the growth of disorder at high pressure. At 37 GPa the diffraction peaks are hardly noticeable and at 41 GPa they disappear suggesting pressure-induced amorphization.

The first broad amorphous diffraction peak continues to shift to larger 2θ in the amorphous phase. This is due to densification of the amorphous phase. When the pressure is released from 53 GPa, the crystalline pattern does not reappear. On the other hand, the amorphous diffraction peak persists suggesting that the amorphous phase formed at high pressure is recoverable at the ambient pressure. These results raise a question whether *a*-V_2O_5 formed at high pressure is different from glassy-V_2O_5 [5, 6] obtained from melt-quenching or vapour deposition on cold substrates similar to SiO_2 [7]? Further analysis of the amorphous pattern is in progress.

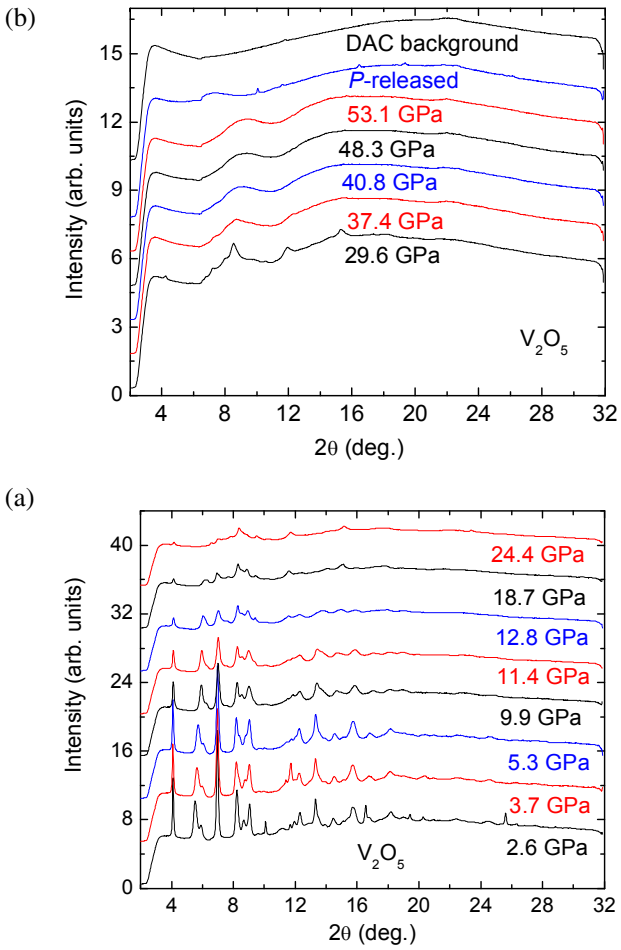

Fig. 1. Diffraction patterns of V_2O_5 at different pressures.

References

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