Phase Formation and Crystallinity of $Pr_2Ir_2O_7$ Thin Films

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$Pr_2Ir_2O_7$ is known to have many intriguing physical properties, including a spin ice state and lack of long-range magnetic order at low temperatures. Quadratic band touching observed in $Pr_2Ir_2O_7$ bulk crystals [1] has been suggested to enable the formation of a topological insulator phase or a Weyl-semimetal phase if a corresponding symmetry is broken by lattice distortion, which is difficult to achieve in bulk crystals. Thus, we study PLD growth of $Pr_2Ir_2O_7$ films with the aim of obtaining stoichiometric surfaces that are required for, e.g., ARPES measurement.

Films with different compositions were grown on YSZ (111) substrates. Typical x-ray diffraction patterns of the films are shown in Figure 1. We find that the $Pr_2Ir_2O_7$ phase can be deposited directly by PLD at a low oxygen partial pressure (0.3 mTorr) and high temperature (1000°C) conditions (Fig.1(c)). However, competition between oxidation of praseodymium and formation of the pyrochlore structure leads to PrO_x secondary phases in the films. We investigated the praseodymium valences change, which is strongly related to the oxygen partial pressure under various deposition conditions (Fig. 2).

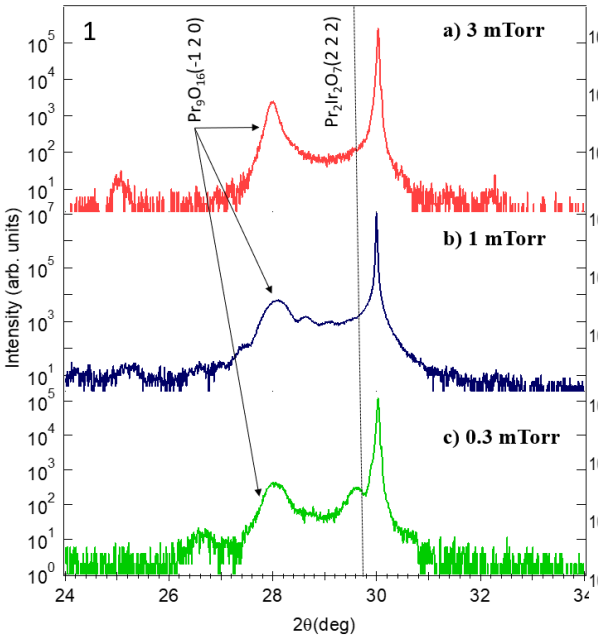

Fig. 1 XRD 2θ-θ scans of $Pr_2Ir_2O_7$ films grown at different oxygen pressures.

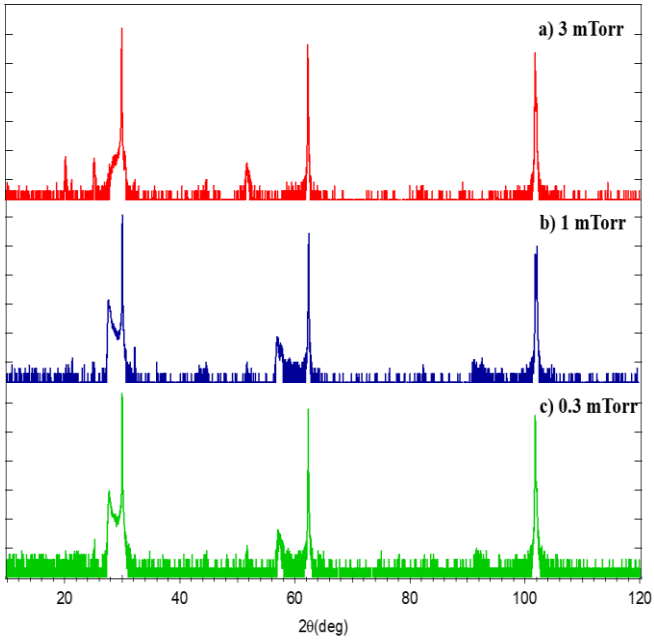

Fig. 2 XRD 2θ-θ scans of PrO_x films grown at different oxygen pressures.

[1] T. Kondo, *et al.*, *Nature Commun.*, Vol. 6, p. 10042, 2015.