Program Number: S3.17 **Day / Time:** Tuesday, Nov. 29, 8:00 PM - 11:00 PM

P - Type Amorphous Oxide Semiconductors Ln - Ru - O from Solution Processing.

J.Li[1]; E.Tokumitsu[1,2]; M.Koyano[3]; T.Shimoda[1,3]

1. ERATO, Shimoda Nano-Liquid Process Project, Japan Science and Technology Agency (JST), Nomi, Ishikawa, Japan; 2. Precision and Intelligence Laboratory, Tokyo Institute of Technology, Yokohama, Japan; 3. School of Materials Science, Japan Advanced Institute of Science and Technology, Nomi, Ishikawa, Japan

We have synthesized a class of amorphous semiconductors Ln-Ru-O (Ln = lanthanide elements except Ce) using a simple solution deposition process. The films show low resistivity (down to 10^{-2} - 10^{-3} Ω cm) around room temperature. La-Ru-O was analyzed as a representative, with comparison to sputtered samples. Resistivity-temperature relation analysis revealed semiconducting behavior with carrier transport by variable range hopping. Seebeck measurement indicated the carriers were p-type. The valence band structure was analyzed using ultraviolet and X-ray photoelectron spectroscopy, which showed a valence band hybridized with O 2p and Ru 4d orbitals, explaining the origin of p-type conduction. The optical band gap is around 1 eV. The film surfaces have excellent smoothness (root mean square roughness <0.3 nm and peak-valley < 3 nm by AFM on 1 μm × 1 μm area). The solution process is not only simple and of low cost, but also resulted in films of lower resistivity. Compared to other oxides and processes, these materials have several advantages. First, they may be the lowest in resistivity (around 2 orders lower) among amorphous oxides deposited by solution techniques. Second, they are novel p-type amorphous oxides originated by a solution process. Before these oxides, only sputtered Zn-Rh-O with a resistivity of ~0.5 Ω cm was known as a p-type amorphous oxide. Third, they have excellent thermal stability, remaining amorphous state up to 800 °C. Fourth, the solution processing temperature can be 400 °C or lower. Further, an advantage to stressfor amorphous materials over crystals is that amorphous materials are well compatible with scaling down. By using these, it would be very easy to make a nano-pattern, because amorphous materials are neither constrained by the crystal size, nor distorted/damaged during crystallization as found in the process of crystalline materials. Therefore, these materials have a high potential in electronic applications. The solution process offers further advantages for low cost and direct patterning (e.g., by imprinting).

Citation: J.Li, E.Tokumitsu, M.Koyano, T.Shimoda. P - Type Amorphous Oxide Semiconductors Ln - Ru - O from Solution Processing.. Program No. S3.17. *2011 Abstract Viewer.* Boston, MA: Materials Research Society