Development of Durable, Cost-effective, and Efficient Tubular Solid Oxide Fuel Cell

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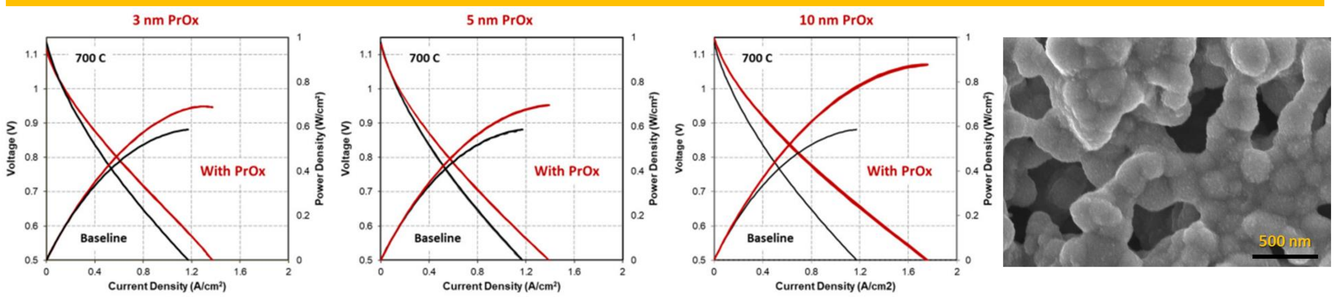
Abstract

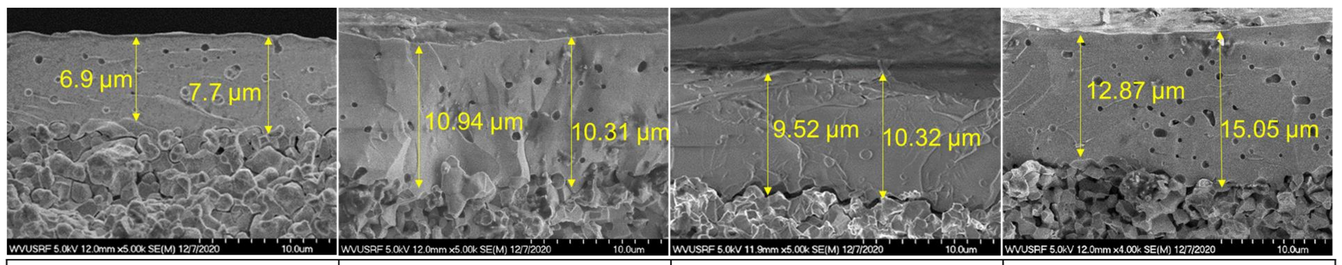
Special Power Sources (SPS) endeavors to build a next generation tubular SOFC stack with low degradation, high energy efficiency, and low cost. To achieve the durability and cost metrics desired, cell development in several areas were carried out, including electrolyte layer thickness reduction, cell performance enhancement through electrode infiltration, and cell cost reduction by optimizing Ag current collector printed pattern without comprising cell performance. The combined new cell technology advancement mentioned above is being tested in long-term single tube test and >500W bundle test. Significant cell performance improvement and has been demonstrated, and long-term cell stability is currently being evaluated.

Electrode Infiltration



➢ **Figure 1.** Effect of PrO_x coating layer thickness via ALD on cell performance at 700° C. Infiltrated PrO_x nano-particles can be observed on the electrode particles surface as shown in the SEM image on the right.

Thinner Electrolyte



Standard Solid Loading	33% Higher Solid Loading	Standard Solid Loading	33% Higher Solid Loading
Translation Speed:2X	Translation Speed: 2X	Translation Speed: 1X	Translation Speed: 1X

➢ **Figure 2.** SEM images of electrolyte on the cells sprayed with different solid loading and spraying speed. (Measured electrolyte layer thickness for each condition shown.)

Summary

1. New cell developments including electrode infiltration and thinner electrolyte have been introduced to SPS's tubular fuel cell. The results show these combined enhancement can increase power by more than 20% over SPS's standard cell at the same voltage, but 100°C lower temperature (Figures 1, 2, and 3).
2. Durability test of single tube with enhanced technology shows a power degradation rate of <0.5%/Khrs. This translates to a 2.5 years lifetime, assuming cell life is defined by 10% loss of power (Figure 3).
3. Long-term (5000 hrs) durability testing of an enhanced cell technology bundle in a full system performance test is ongoing. Results have shown favorable degradation rates over 3500 hours (Figure 4).

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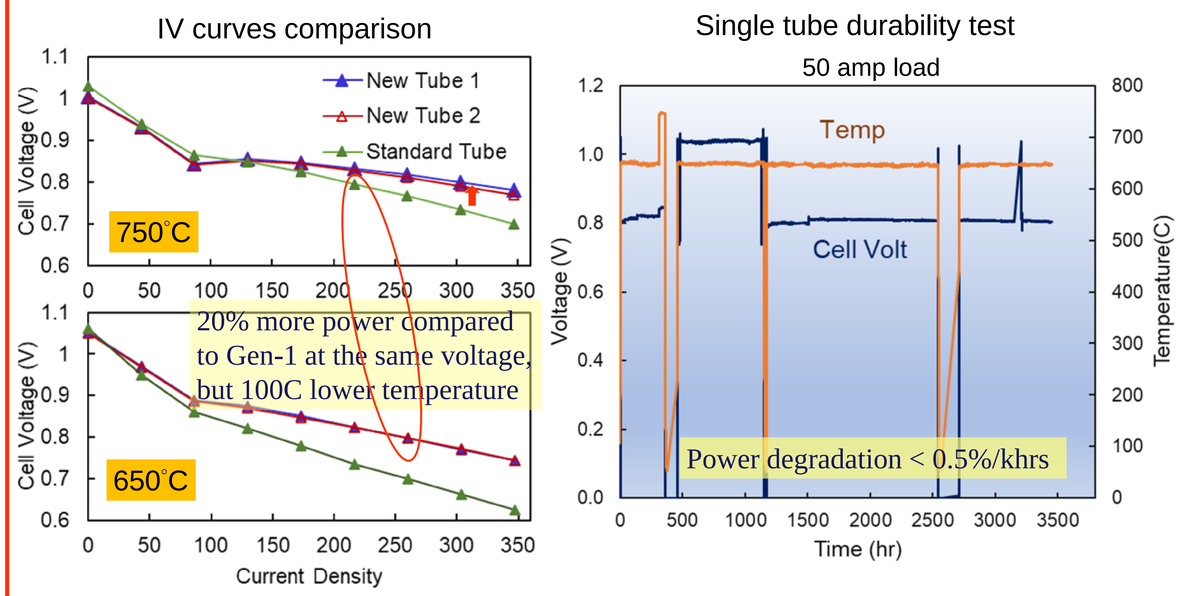
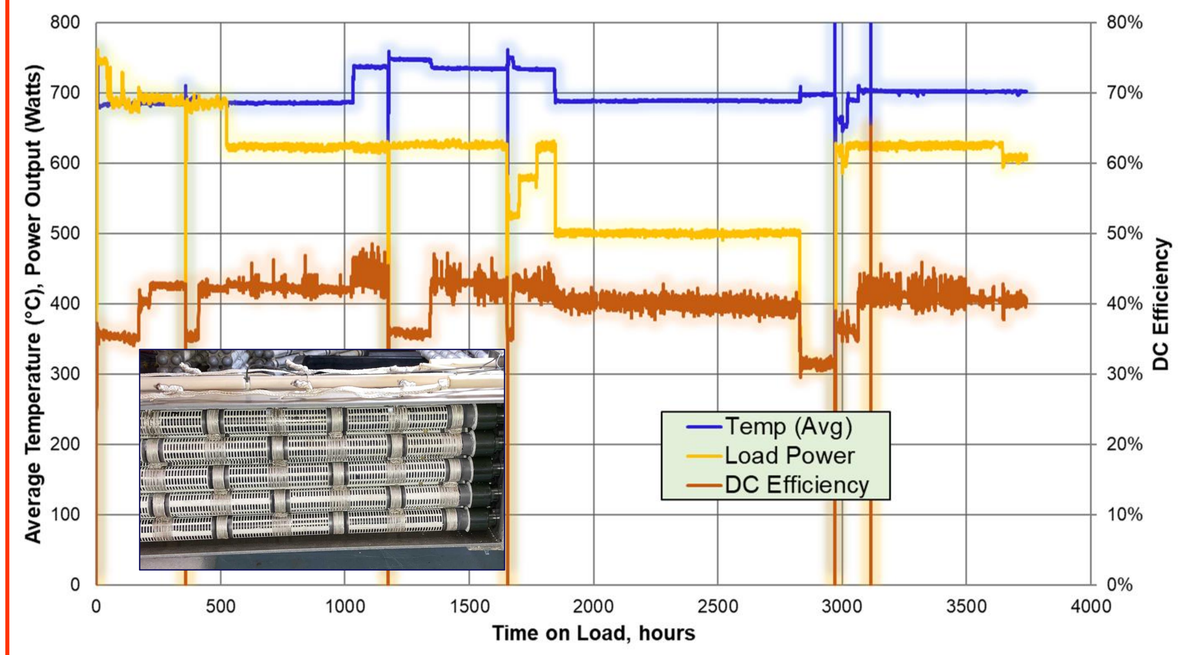
Cell performance of Cell with enhanced technology



➢ **Figure 3.** Left: IV curves comparison between standard technology cells and cells with new enhanced technology. Right: Durability test of cell with new enhanced technology. 2.5 life year if defined by 10% loss of power.

Enhanced Technology System Test



➢ **Figure 4.** System performance test of an enhanced cell technology bundle. The test is being performed under various conditions (output load, fuel utilization, temperature, and O/C ratio) to evaluate fuel cell bundle long-term performance in a system environment.