PROPOSAL ABSTRACT:

Name of Principal Investigator:	**Mangalaraja Ramalinga Viswanathan**
Proposal Title:	**Design and development of La-pervoskite-type materials based mini-tubular reversible solid oxide cell for electrical energy generation and hydrogen fuel production**

Describe the main issues to be addressed: goals, methodology and expected results. **The maximum length for this section is 1 page** (Must use letter size, Verdana size 10 or similar).

In the recent past, the use of hydrogen as a clean fuel in replacing the gradually depleting supply of fossil fuels is increased. However, hydrogen is not a natural resource and must be extracted from other H-contained materials, eg. Fossil fuels or water. Thus the production of H_2 gained attention of the world wide scientific community to meet the commercial requirement. Also, the excess electrical energy generated from the efficient photovoltaic cells is lost if not used or stored. The excess energy can be stored by using batteries or can be converted into chemical fuels. The solid oxide fuel cell (SOFC) operating in reverse configuration, can convert the electrical energy into chemical fuels by electrolysis. The conversion of electrical energy into chemical fuels by using solid oxide electrolysis cells (SOEC) is advantageous over the battery storage system in cost and efficiency. High temperature electrolysis is more efficient economically than traditional room-temperature electrolysis because some of the energy is supplied as heat, which is cheaper than electricity, and also because the electrolysis reaction is more efficient at higher temperatures. The direct production of fuel gas (H_2) using SOEC is much more advantageous for industrial applications based on H_2 gas. Apart from this, by operating in SOFC mode the fuels can be converted back to electricity. Thus a typical reversible solid oxide cell (ReSOC) can be efficiently operated as an electrolysis cell for fuel production and as fuel cell for electrical energy production. By interconnecting with photovoltaic cells, the typical reversible solid oxide fuel cell can be used as a fuel producer in day-time and as an electricity generator during the night-time. A typical operation of the SOFC mode requires excess heat rejection while SOEC mode requires heat supply to maintain the desired ReSOC operating temperature. In SOEC mode, the H_2/CO oxidation and steam/CO_2 reduction reactions are highly exothermic and endothermic, respectively. Thus the significant challenge of designing ReSOC system is its thermal management. The redox stability of the electrodes in the reverse operating mode is a major concern for the performance of the ReSOC. The search of new materials as a redox stable electrodes with high ionic conductivity is inevitable. Recently, Perovskite structure based materials demonstrate a promising material for ReSOC configuration due to their ability to tolerate extensive modifications in their compositions to obtain desirable characteristics suitable for different components of the solid cells.

Here by, we propose the development of La-pervoskite-type materials based mini-tubular ReSOC modules and their performance analysis in SOEC mode for fuel and SOFC mode for electricity generation. In the current proposal, Co-free La-perovskite based materials are chosen to fabricate the ReSOC components to mitigate the microstructural damage by decreasing the polarization resistance of the oxygen electrode.

So, in the current proposal, we have planned to develop La-perovskite nanostructures based mini-tubular reversible solid oxide cells to future energy consumption:

- Synthesis and characterization of (i) Sr and Mg doped lanthanum gallate (LSGM) for electrolyte, (ii) Sr and Cr doped lanthanum manganite (LSCM) for fuel electrode, (iii) Lanthanum strontium manganite (LSM) for oxygen electrode materials by using wet chemical self-sustaining combustion synthesis and (iv) Gd doped CeO_2 by using wet chemical synthesis for inter-diffusion barrier layer are proposed.
- Various characterization techniques like XRD, SEM, TEM, XPS, Raman, TG-DTA and current-voltage studies for particle size, phase analysis, morphology, electrical conductivity and thermal properties will be analyzed.
- For the fabrication of ReSOC module (i) the extrusion process for the mini-tubular substrates (fuel electrode) will be developed and optimized. (ii) Lab-customized spray coating technique for the realization of electrolyte and oxygen electrode layer in the cell configuration.
- Performance analysis of individual mini-tubular cells in SOEC mode for fuel and SOFC mode for electricity energy generation.

By the end of the project we will be privileged to provide a protocol for the mechanically and thermally stable, high cell efficiency, high temperatures (700-1000°C) operating individual mini-tubular cells, that can be operated in switchable SOEC and SOFC modes, to be commercialized with national and international agencies.