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Title: Construction and development of an ultrasonic spray pyrolysis system for semiconductor thin films deposition to photovoltaic applications

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PRESENTATION CONTENT

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INTRODUCTION

Solar cells are divided into three categories, differentiated by the primary technology applied, categorized as first, second, and third-generation cells. First-generation cells are mainly composed of silicon wafers doped with an electron carrier material. The second generation consists of less expensive materials such as metal oxides, and their thickness is considerably reduced. Lastly, the third generation is characterized by using cutting-edge technology that is still in an experimental state, making it non-commercial like its predecessors.

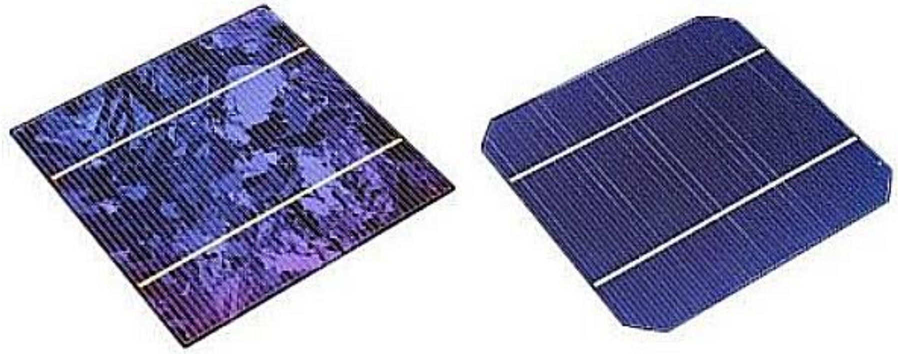

Fig.1 Commercial first-generation silicon cells, both crystalline and monocrystalline.

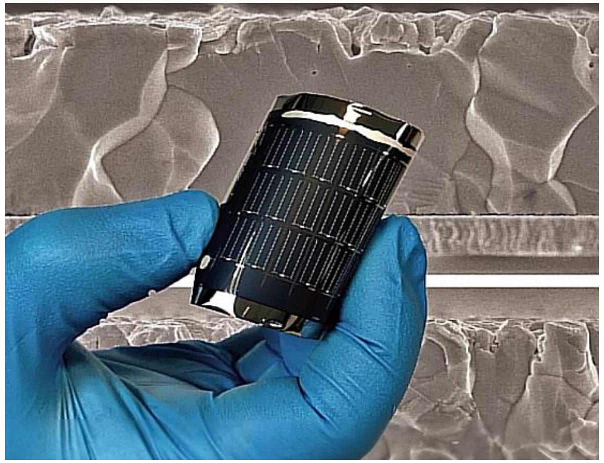

Fig.2 Ultra-thin second-generation cells (their small thickness allows flexibility).

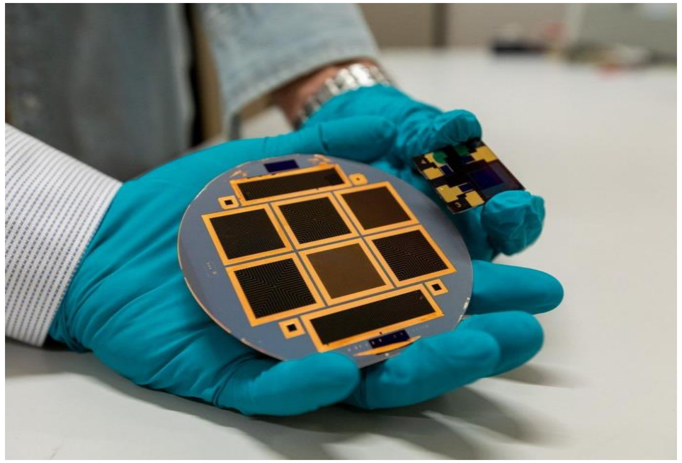

Fig.3 Perovskite third-generation cells.

INTRODUCTION

To produce semiconductor sheets that are so thin, it is necessary to deposit the material rather than mechanically cutting ingots of it. Over time, different methods have been developed for the deposition of metallic and semiconductor materials. One such method is Ultrasonic Pyrolytic Spraying, which has the advantage of being a controllable, low-cost process that can yield high-quality materials. Additionally, it is a simple method to replicate.

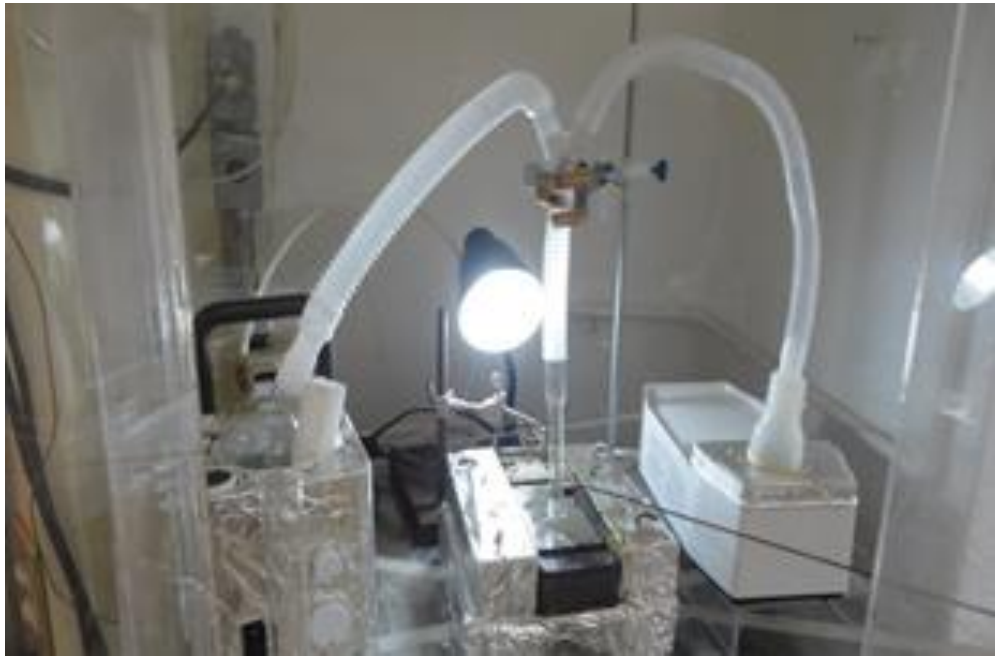

Fig. 4 Example of an RPU reactor.

INTRODUCTION

To fabricate thin sheets using this method, the powdered semiconductor material is dissolved in a liquid to be ultrasonically nebulized. Then, through a non-reactive gas, the nebulized material is transported in a constant laminar flow and deposited onto a heated substrate at a constant temperature, where the solid material forms into thin sheets less than a millimeter thick.

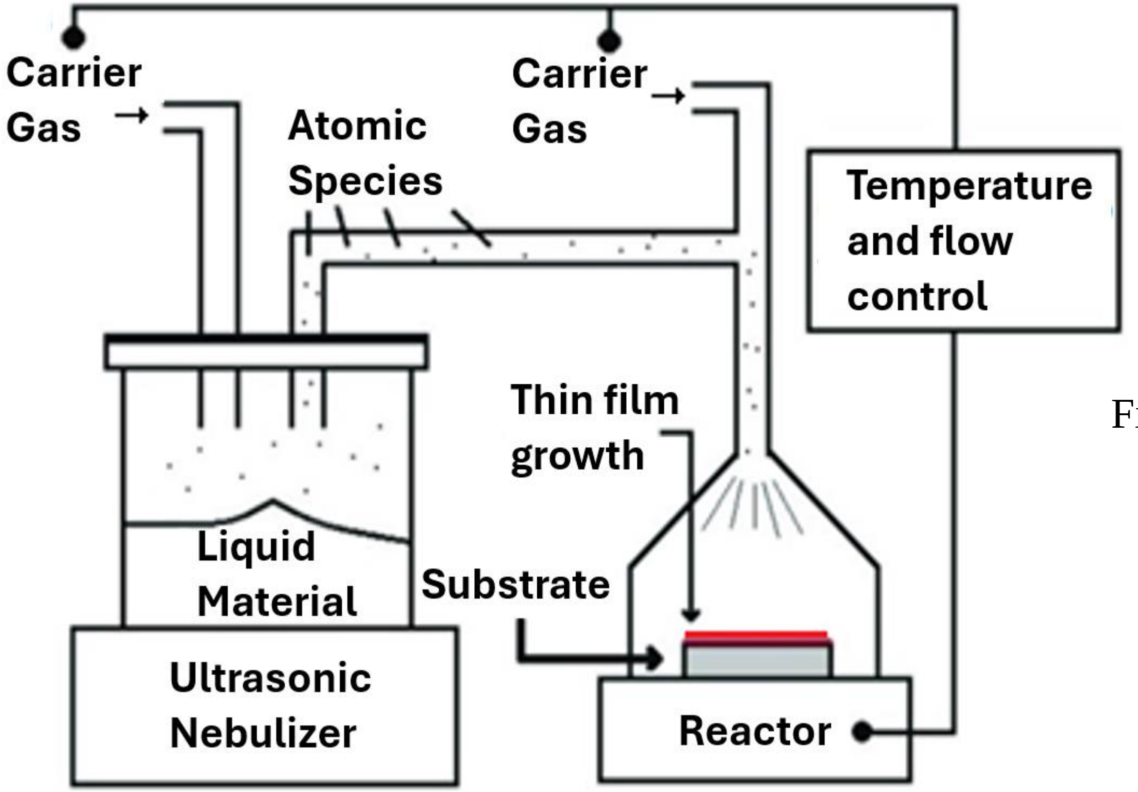

Fig. 5 Operating diagram of an RPU reactor,

METHODOLOGY

For the construction of the reactor, a system for heating liquid tin using tungsten resistances was designed to have greater control over the temperature applied to the glass substrate. Once the heating device was assembled, heating tests were conducted to determine its maximum operating temperature. Liquid tin was used to avoid the Leidenfrost effect of droplets on the hot plate, thereby improving the quality of the samples.

Fig. 6 Heat production system for tin smelting.

Fig. 7 Performance tests and maximum operating temperature.

METHODOLOGY

For ultrasonic nebulization, the YUEHUA model WH-2000 device was used, which is a medical grade ultrasonic nebulizer. And to conduct the nebulization to the substrate, industrial grade nitrogen was used as a director gas and flow tests were performed to check its laminarity.

Fig. 8 Clinical nebulizer YUEHUA WH-2000.

Fig. 9 Performance tests and laminar flow testing

RESULTS

During preliminary tests, the system achieved temperatures exceeding 300°C, with a peak of 600°C after approximately 15 minutes of exposure. The use of industrial-grade nitrogen gas for nebulization, along with a network of polyurethane pipes, ensured low reactivity and promoted laminar flow, which is crucial for the formation of high-quality films; this system allows a maximum flow rate of up to 30 liters per minute.

Fig. 8 Clinical nebulizer YUEHUA WH-2000.

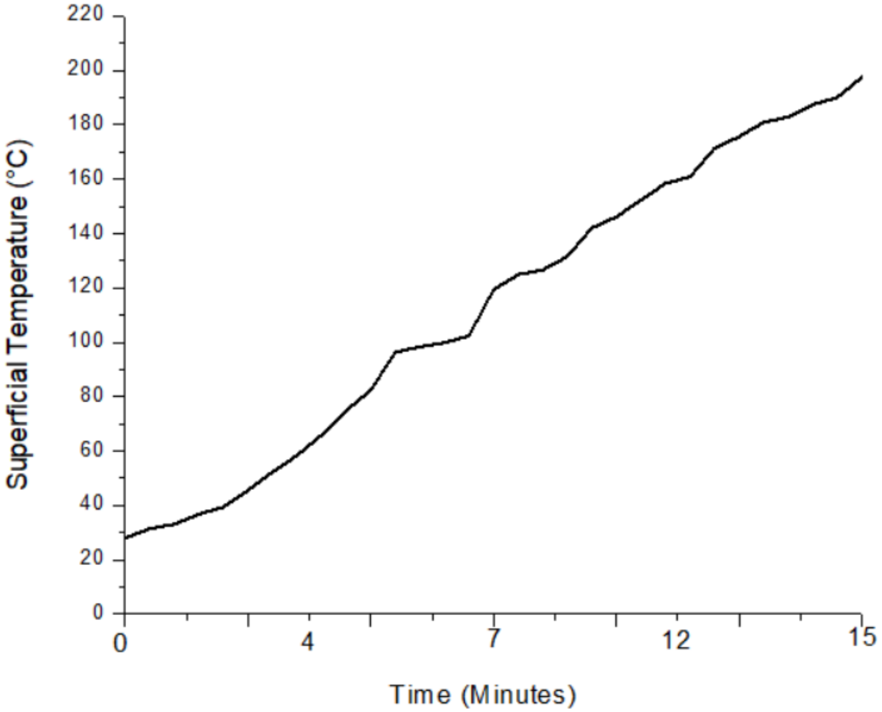

Fig. 9 Pruebas de temperatura.

CONCLUSIONS

The construction, development, and implementation of an Ultrasonic Spray Pyrolysis system have been achieved. The system's component integration and preliminary testing have demonstrated significant advancements in the controlled temperature and deposition processes. The system, composed of three distinct modules, the ultrasonic nebulizer, effectively maintained stable operational conditions for thin film deposition.

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