Annealsys extends RTP systems capability to ALD and doping processes

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Annealsys successfully transferred Atomic Layer Deposition and metal doping processes to on-site RTP systems. In a ALD process, sequential injection of precursors allows the depositions of atomically flat and controlled thickness thin films. Two ALD processes have been developed: Al_2O_3 for applications in passivation, encapsulation and gas barrier, and ZnO, a wide band-gap semiconductor used in applications ranging from thin film transistors (TFTs) to solar cells. The combination of ALD and RTP in a single and reliable Annealsys system opens the way to a broad variety of critical applications.

« Atomic Layer Deposition (ALD) is a well-known and widespread deposition technique that allows the **depositions of a large variety of materials at temperatures as low as room-temperature**. By sequential exposure of a substrate to two precursors species, the technique enables **stoichiometric fine-tuning and atomic-control of the thickness** of the deposited film as well as **superior conformality** to very high aspect-ratio structures. As such, one major use has been in passivation layer deposition, and among this family, aluminum oxide, Al_2O_3 emerged as an outstanding material.
With the idea to **combine in-situ passivation to rapid thermal processing**, Annealsys integrated and demonstrated **thermal ALD of two key oxides: aluminum oxide, Al_2O_3, and zinc oxide, ZnO as well as controlled metal doping (Al, Zn) in one of its RTP system**, the AS-One, opening the way to a large spectrum of applications. Given the close architecture of all its RTP solutions, integration to other systems is possible.

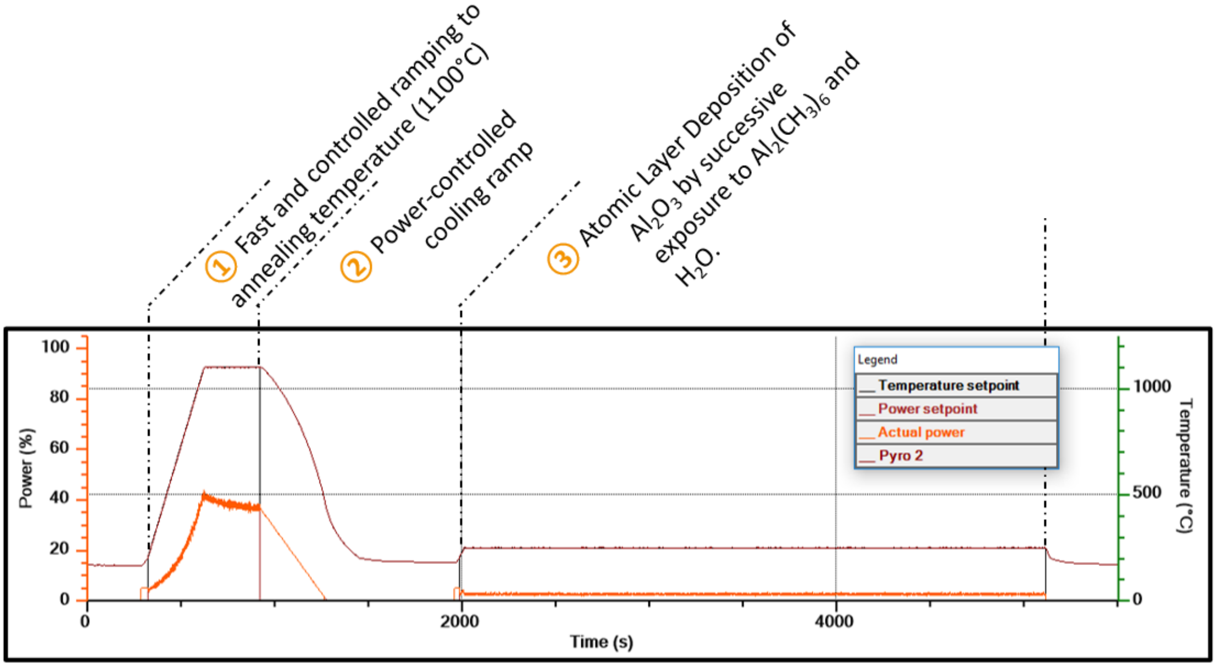

Figure 1 Rapid Annealing at 1100°C followed by ALD encapsulation of 20 nm Al_2O_3. Having both possibilities in a single tool enables annealing and passivation in a single process.

On one hand, **Zinc oxide** is a wide bandgap semiconductor with tunable electrical conductivity as well as good transparency in the visible spectrum, as such, it has been employed in **applications ranging from thin film transistors (TFTs) in microelectronics to solar cells**. ALD of ZnO rose as ever-decreasing dimensions and increasing control in microelectronics systems limited the use of other deposition methods [1]. On the other hand, thanks to its remarkable passivation properties and low deposition temperature, **ALD of aluminum oxide, Al_2O_3, can be used as a passivation layer on p+ substrates**, such as p-type Si-based solar cells, where SiN_x or SiO_2 passivation showed limitations [2]. It can generally be used as a **capping layer** in contact annealing process or 2D material deposition to **prevent surface contamination** and in some cases, enhance properties as well. An example process is presented in Figure 1, where a fast annealing at high temperature is followed by **in-situ Al_2O_3 encapsulation**.

While the setup gives the opportunity to grow thin oxides, it also gives a reliable **metal doping** method. **Precise doping levels and depths** can be obtained by successive injections of a controlled amount of precursor followed by a precise **in-situ fast annealing**. Annealsys successfully applied such process in making **Zn-doped thin films**. An illustration is presented in Figure 2. Likewise, Al-doped ZnO is a strong candidate in **n-type substrate passivation** where such ALD thin films **showed remarkable performances** [3].

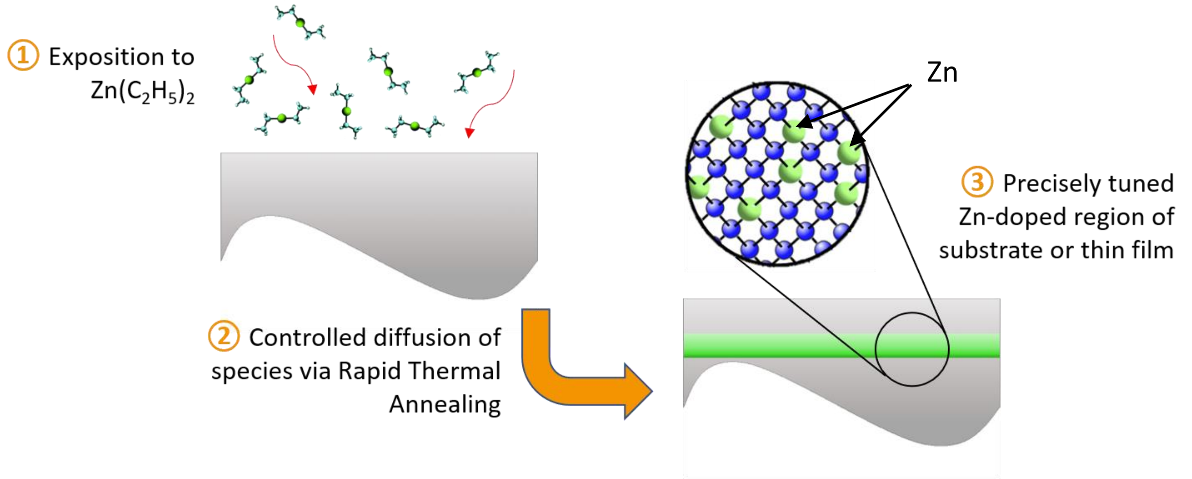

Figure 2 Schematic representation of Zn-doping via succession of DEZ injection and Rapid Thermal Annealing in a Annealsys RTP system.

Essentially, having both water vapor injector and precursor vapor injector and combining it with a reliable Annealsys RTP system opens the way to a multitude of processes using either a single injector (metal doping (Figure 2), humid oxidation, solvent-based graphene growth…), or both injectors (encapsulating oxide ALD (Figure 1), surface treatment…).

For more information contact us: sales@annealsys.com

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[1] [http://iopscience.iop.org/0268-1242/29/4/043001] Tynell, Tommi, and Maarit Karppinen. "Atomic layer deposition of ZnO: a review." *Semiconductor Science and Technology* 29.4 (2014): 043001.

[2] [https://link.springer.com/article/10.1007/s11082-020-02689-8] Banerjee, Sudipta, and Mukul K. Das. "A review of Al2O3 as surface passivation material with relevant process technologies on c-Si solar cell." *Optical and Quantum Electronics* 53.1 (2021): 1-25.

[3] [https://doi.org/10.1016/j.solmat.2021.111386] Macco, Bart, et al. "Atomic-layer-deposited Al-doped zinc oxide as a passivating conductive contacting layer for n+-doped surfaces in silicon solar cells." *Solar Energy Materials and Solar Cells* 233 (2021): 111386.