Development and qualification of interconnection for perovskite solar cells in a space environment

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Nano-satellites and CubeSats require photovoltaic generators that are lightweight, low-cost and efficient. Among alternative solar technologies, perovskite (Pk) solar cells stand out as a promising candidate [1], yet interconnection scheme and thermal cycling remains a challenge for adequate endurance in Low Earth Orbit (LEO) [2]. In this study, we develop and investigate an interconnection solution capable of improving electrical continuity and mechanical robustness for Pk cells electrical connections subjected to severe thermal cycling between −120 °C and +120 °C.

Two bonding technologies were compared on ITO/Cr/Ag glass substrates (Figure 1): a pressure-sensitive adhesive (PSA) and a silver-filled electrically conductive adhesive (ECA) applied with or without a silver-lacquer layer and with or without surface treatment. Performance was characterized by four-point contact-resistance measurements and 90° pull tests. For each of the four configurations, measurements were taken before and after 200 space-representative atmospheric pressure thermal cycles (Figure 2).

The PSA showed insufficient adhesion (<15 mN) and electrical conduction (>1 MΩ). By contrast, the “ECA + surface treatment” configuration maintained a contact resistance below 10 Ω and lost only about 10 % of its mechanical strength after 500 thermal cycles and 40 thermal-vacuum cycles, without requiring a stress-relief loop, and without any noticeable outgassing. Thermal cycling is ongoing, and the robustness of the contacts is currently being evaluated over an extended number of thermal cycles. Initial tests on active PIN Pk cells confirm electrical and mechanical stability. However, the Pk absorber itself deteriorates rapidly under thermal cycling, notably showing delamination of the Pk layer and a loss of electrical current. The strategy to mitigate thermal stress within the cell stack and overall maintain stable material properties over large thermal range remains a key for future Pk powered space missions.

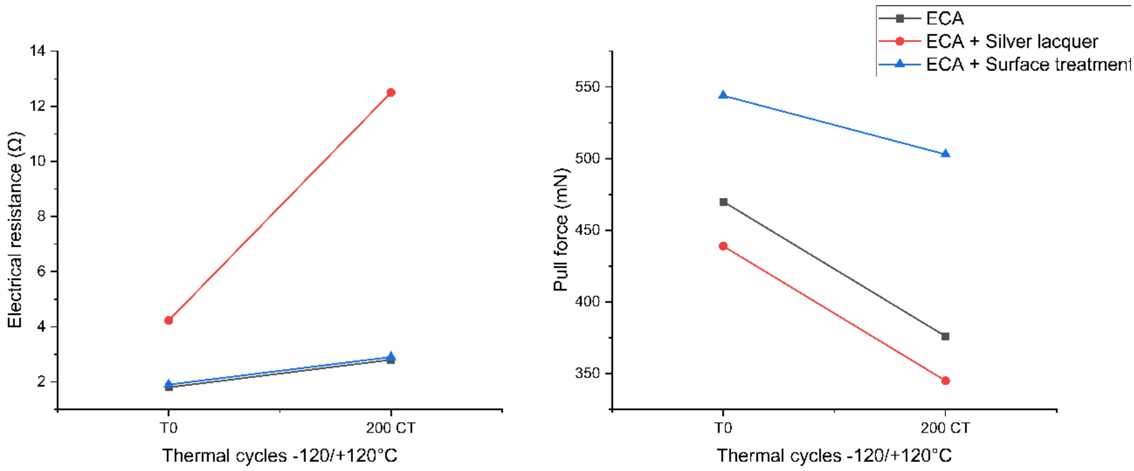

Figure 2 : Impact of thermal cycling on electrical and mechanical performance

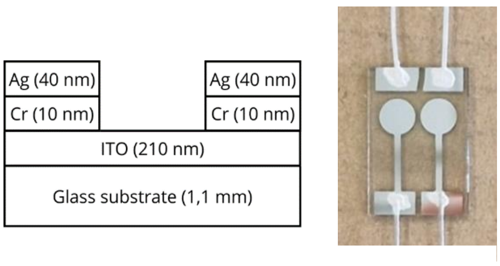

Figure 1 : Schematic and photograph of the glass substrate used in the interconnection tests

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[2] M. E. Bush, J. D. Sims, S. S. Erickson, K. T. VanSant, S. Ghosh, J. M. Luther, and L. McMillon-Brown, Space environment considerations for perovskite solar cell operations: A review, Acta Astronautica **235**, 235 (2025).