National Aeronautics and Space Administration

TRL Advancement and Qualification for UV and UV/Optical Photon Counting & Scientific Silicon Detector Arrays

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Program: FY22 R&TD Strategic Initiative
Strategic Focus Area: UV Spectroscopy - Strategic Initiative Leader: Margaret A Frerking/Charles Lawrence

Objectives: The objective of this R&TD effort was to create, characterize, and environmentally test a statistically significant number of high efficiency ultraviolet (UV) scientific detectors in order to qualify UV detector technologies for future missions.

Background: Astro2020 Decadal Survey recommended a 6-m flagship UV/O/IR observatory inspired by HabEx and LUVOIR concepts. There are a several UV Explorer mission concepts that require high performance UV photon counting and scientific detectors. JPL's 2D detector technologies are enabling for the above missions. This effort addressed the need for advancing the maturity of the technology and qualifying the processes.

Approach and Results: For qualification, we chose a large format scientific CCD (CCD272: 4kx4k, 12µm pixel) and an EMCCD for photon counting (CCD 201: 1kx1k frame transfer, 13 µm pixel). Te2v supplied wafers of each kind, JPL processed these wafers, delivered to Te2v the wafers for packaging and testing (performance and environmental), and worked with Te2v on analyzing test results (Figure1 and 2). Under this task, we optimized processes to improve quality of wafers after processing (Figure 3). Multiple wafers were processed and QE was independently verified (Figure 4). Several critical risks factors were identified and mitigated. More wafers (supplied by Te2v) need to be processed to produce devices to complete qualification. The work will continue in part funded by a one-year ROSES-SAT task.

Significance/Benefits to JPL and NASA: High-performance, high-efficiency ultraviolet and ultraviolet CCDs that are mature and reliable in fabrication increases the chance of success in future mission proposals and mission implementation.

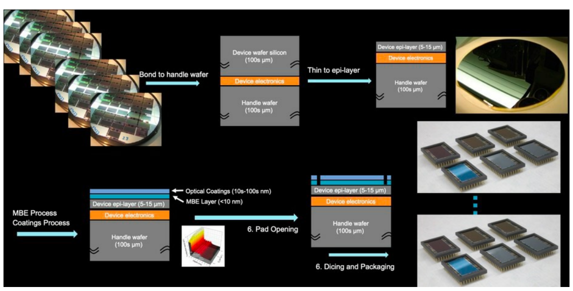
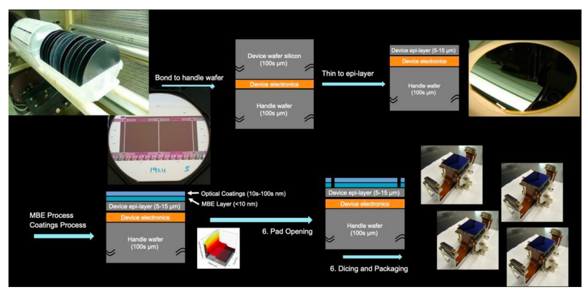


Figure 1. JPL 2D doping process flow showing electron multiplying CCD (EMCCD)-CCD 20--wafers and packaged devices.



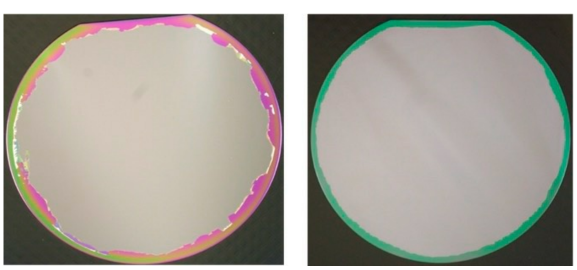


Figure 3. Improved processing of planarization, bonding, and surface preparation led to mitigating previously-seen delimitation problem (left wafer) leading to marked improvement in final wafer with little to no delimitation and therefore yield improvement (right).

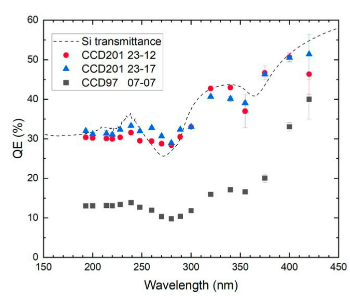


Figure 4. Independent quantum efficiency measurement at Open University and their comparison with Te2v's UV- enhancedprocess showed significantly superior performance in 2D-doped Te2v devices.

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Publications:

Shouleh Nikzad, A. Jewell, J.J. Hennessy, M.E. Hoenk, (Invited Paper) " Enabling Optical Coatings for Sensors and Detectors in Space Astrophysics and Planetary Applications," in Optical Interference Conference, June 2022.
Shouleh Nikzad, M.E. Hoenk, A. Jewell, G. Kyne J.J. Hennessy, (Invited Paper) " Advanced UV-NIR Detector Technology Development at JPL in Strategic Partnership with Industry and Academia," in Scientific Detector Workshop, September 2022.

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