Flexible solar cells

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Y.L. conceived the idea, designed the cells, explored the mechanisms, and wrote and revised the manuscript. X.R. designed the experiments and fabricated the solar cells. M.Y. guided the experimental fabrication technology. Y.Z. was responsible for the flexibility simulation and measurement, figures, tables and preparation for publication. S.Y. and C.H. developed the TCO process. F.P. developed the metallization process and conducted the efficiency certification. M.Q., C.X., J.L. and L.F. managed the project and participated in experiment design. C.S. assisted in characterization and data analysis. D.C., J.X. and C.Y. provided resources and funding support. Z.L. and X.X. organized the research. Z.S. supervised the project.

Jiangsu University of Science and Technology is in the process of applying for a Chinese invention patent (202311478687.5) related to the subject matter of this manuscript. Z.L. and X.X. are co-founders of LONGi Central R& D Institute. X.R., M.Y., S.Y., C.H., F.P., M.Q., C.X., J.L. and L.F. are employees of LONGi. The other authors declare no competing interests.

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a, Cross-sectional morphology of the c-Si/i:a-Si:H interface. b, Cross-sectional morphology of c-Si/hydrogen-rich i:a-Si:H/a-Si:H. c, Enlarged cross-sectional morphology of the i:a-SiOx:H (1)/a-Si:H (2) composite gradient passivation layers prepared via continuous-plasma CVD.

Effect of hydrogen content (CH) variation in the epitaxy-preventing composite gradient passivation layers on cell performance. The dashed lines in the panels are fit lines to evaluate the data change trends.

a, Cross-sectional HRTEM image of the doped contact layer fabricated via conventional random growth. b, Cross-sectional HRTEM image of the doped contact layer fabricated via self-restoring NSVGI.

a, Relationship between the FF and crystallinity fraction of the n+:nc-SiOx:H window layer with a p+:a-Si:H

rear emitter. b, Relationship between the FF and crystallinity fraction of the p+:nc-Si:H rear emitter with the optimal n+:nc-SiOx:H window layer. c,d, Variation of CH in i:a-Si:H (2) with sowing duration via self-restoring nanocrystalline sowing and unrestricted nanocrystalline sowing, respectively. e, Enlarged cross-sectional HRTEM image of i:a-Si:H (2) after the unrestricted nanocrystalline sowing. The dashed lines in the panels (a, b, c, d) are fit lines to evaluate the data change trends.

Comparison of the cell performance parameters via conventional screen printing and contact-free laser transfer printing (LTP).

Encapsulation schematics for the SF and FT SHJ modules, as well as the laboratory accreditation certificate for the third-party assessment. The certificate is reproduced with permission from Changzhou Sveck Photovoltaic New Material Co., Ltd.