The first-order proximity-enhancement of thermo-photovoltaic energy conversion that we and CSDL demonstrated for the first time several years ago [1, 2] leads to a dramatic and important increase in energy conversion rate but only a modest increase in the efficiency of the conversion process. The challenge we are addressing now is to use the micro-scale geometry (in which the hot and cold surfaces are in extreme proximity) to increase the efficiency of thermo-photovoltaic energy conversion as significantly as we have increased the conversion rate.

Our work supports the C. S. Draper Laboratory (CSDL) effort on micro-scale thermo-photovoltaic (MTPV) electrical power sources. We have provided InAs-based MTPV cells to the CSDL effort; we have analyzed the impact of the enhancement effect on TPV cell performance; and we have evaluated more sophisticated, quantum-effect-based phenomenon that can be used to enhance significantly the energy selectivity of the energy transfer, and thereby dramatically increase the efficiency of the thermal to electrical energy conversion. We have most recently also begun work on dot-junction, back-side-illuminated solar cells. In the past year we have designed an original InGaAlAs-on-InP heterostructure suitable for fabricating high performance dot-junction, back-side illuminated solar cells shown in Figure 1, and proposed an accompanying fabrication sequence. Referring to Figure 1, the uppermost n+ InGaAs layer is the n-side of the junction and a low-resistance contact layer. The InGaAlAs layers shield the minority carriers created in the wide, p-type InGaAs light-absorbing layer from surface recombination; the composition of this layer is graded to eliminate any barrier to electron flow from the absorbing layer to the n-side of the junction. The lowest p+ InGaAs layer reduces resistance as carriers flow laterally to ohmic contacts made to the p-side of the junction. The first sample of this heterostructure has been grown and CSDL researchers are doing fabrication and testing of the first set of devices.

Figure 1: The layer structure for dot-junction, back-illuminated TPV and MTPV cells

REFERENCES: