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# Thin Film Partnership National Research Teams

## Preprint

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# Thin Film Partnership National Research Teams

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**ABSTRACT**

The Thin Film Partnership has organized three National Research Teams in CIS, CdTe, and amorphous silicon. This paper reports on their structure, accomplishments, future plans, and organizational dynamics.

## 1. Introduction and Perspective

The Thin Film Partnership is the DOE/NCPV Program designed to accelerate the progress of thin film PV technologies. Three technologies (a-Si, CIS, CdTe) have reached pilot or first-time manufacturing. The Partnership organized National Research Teams made up of researchers from NREL, US industry, and universities in each of these options. These Teams have been in existence for over six years. About forty researchers are active within each Team, making the Teams an important resource. Areas of collaboration are defined by each Team, and active research is carried out and reported at approximate nine-month intervals. Each Team is organized differently in response to their own specific and evolving needs.

A new Team is being formed as a result of the most recent re-competition: a National Thin Film Silicon R&D Team. This Team will work closely with the existing amorphous silicon Team, because there are a number of overlapping interests.

## 2. Amorphous Silicon

Until recently (2000), the Amorphous Silicon Team was organized so as to support progress in triple-junction cells. It had a top, middle, and bottom cell Team; and a cell modeling and integration Team to put the pieces together. This was, from the Team's inception, a very successful structure (world records for cell and module efficiencies were achieved consistently). However, in response to evolving needs, the Team changed approaches. Currently, there are areas of ongoing interest defined (high rate deposition, Staebler-Wronski Effect, device efficiency, and modeling) and specifically and temporary focus areas. Research is ongoing in the overriding areas of interest. A workshop is organized at each Team meeting for the temporary but high-energy focus area. This allows collaborations to maintained in the key areas of need; but also introduces variety and new perspectives due to the issue-specific workshops. For example, bottom cells, thin-Si bottom cells, and process dynamics have been workshop topics.

The major focus of current efforts is to discover ways to raise amorphous silicon deposition rates while maintaining film quality. Key recent progress has been achieved by United Solar, ECD, and BP Solar, both at the research level and in their manufacturing approaches. NREL has developed successful super-high-rate deposition by hot-wire (from 15-200 angstroms/s) working closely with United Solar. Higher deposition rates would reduce capital costs, maintenance costs, and start-up costs and risks.

## 3. Copper Indium Diselenide

The CIS Team is going through a major change of direction. During the prior period it focused on company-specific needs, with each portion of the Team organized to support the individual companies. In some cases, confidentiality agreements have been signed. Although this led to significant progress (e.g., in helping Siemens Solar Industries address transient effect issues), the major downside result was that Team unity suffered. Instead of a community working together to advance CIS, it broke down into different groups supporting a company and not the technology. There is sufficient value to the company-specific approach so that it should not be totally abandoned (see CdTe Team approach, below); but the strength of the National Teams seems to be best brought out through approaches that intensify a feeling of community. This stimulates the associations and trust that leads to effective collaborative research.

The CIS National Team is in the process of choosing key research topics for future activities.

## 4. Cadmium Telluride

The CdTe Team has a mixed structure: cross-cutting topics such as device performance and stability; and a single focus group that is working with First Solar on a chosen proprietary topic. The main work of the Team is on the topical areas, but there is leeway to bring resources together to examine a company-specific need on a short-term basis. The Team has made substantial progress, perhaps best illustrated by the rapid efficiency enhancement at the module level achieved by BP Solar, which improved their module efficiency by 100% (from about 5% to almost 11%) and their module size from 1 to 10 $ft^2$ in the last three years.

## 5. Thin Film Si Team

The new Thin Film Si Team is being organized by Bolko von Roedern. The expected members (pending funding availability) are: AstroPower, MVSystems, CalTech, United Solar, ECD, NREL, IEC, EPV, and Syracuse. Emphasis will be on two aspects of thin film Si: low-temperature deposition on glass and high-temperature deposition on ceramic. Collaborations with the Amorphous Silicon Team will emphasize the possible use of thin x-Si as a bottom cell in a multijunction with a-Si. Meanwhile, focused effort on thin x-Si will address the key limiting issues of voltage, light trapping, and high-rate deposition.

## 6. Team Dynamics and Conclusions

In addition to the technical progress resulting from the Teams, there are some interesting observations about things that work and pitfalls that can be made about Team dynamics and effectiveness.

*The real value of the National Teams is in the personal associations that they create.* Researchers learn both the obvious (others' skills, equipment, and interests) and the subtle (who they get along with and can work with). This opens a channel of cooperation that can be exploited both within the Team and outside it. In practice, this means that the right people and resources work on the right topics much more often. It also means that fewer 'off-topic' activities are maintained.

National Teams are exceptionally valuable to newcomers and those in need of additional research capability. The substantial progress at BP Solar in CdTe illustrates this advantage.

One prominent pitfall of Team arrangements could derive from putting Team members in a position to publically compete with their peers for the favor of the funding sources. The DOE/NCPV funds Team members to perform advanced research. If Team members are forced to publically compete, Team activities can devolve to mere showmanship. This is a serious pitfall, not only from the standpoint of wasted hours but in terms of the loss of Team unity. Team events must be organized to minimize the payoff for mere showmanship and progress by 'hand waving'.

The breakdown of the entire Team into non-overlapping areas, such as occurred in the CIS Team, also appears to be a problematic approach. Though it allows for resources to be focused, it separates each sub-team into non-communicative working groups. A sense of scientific progress is sacrificed. This decreases Team unity, effectiveness, and spirit. Perhaps the modified approach of the CdTe Team (a single temporary focus group within a more cross-cutting topical structure) is the proper compromise if circumstances require a company-specific effort.

Another pitfall of Teams is giving others the feeling they are unwelcome. The Partnership National Teams have only one requirement for admission of U.S. members - they must contribute. Funding by DOE is not required. The National Research Teams Want You!


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