



**I N T E V A C**

# **High Productivity low cost Ion Implant for Solar and beyond**

**Lisa Mandrell, Xiaochun Lu, Weibo Guo,  
Babak Adibi, Arun Karamcheti**

**Intevac, Inc.  
Santa Clara, CA, USA**

**October 2017**

**POWERING INNOVATION. DELIVERING VALUE.**



# Intevac Enabling Technology to Important Markets

## Thin-Film Equipment



**Mobility and the Internet of Things**



**Clean Energy / Solar Power**



**Cloud Computing and Storage**

**Addressing Multiple Large Growth Industries**

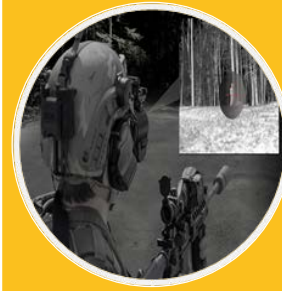
## Photonics



**Night Vision and Target ID Cameras Systems**



**Integrated Night Vision Systems for Gen 5 Heads Up Displays**



**Night Vision and Head Mounted Displays for Soldiers**

**Critical Supplier of Digital Vision Systems**

# Intevac Equipment Business



## 200 Lean® PVD System for Hard Disk



## Intevac Matrix™



## ENERGi™ Ion Implant



- Intevac is a leader in high productivity process equipment
- Leverage capabilities to address multiple advanced applications
- Focus lowering cost of ownership

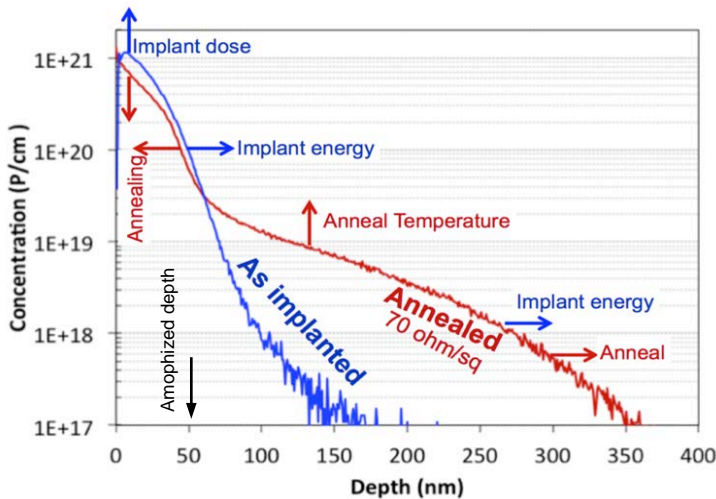
# ENERGi - Enabling Ion Implant for Advanced Solar Applications



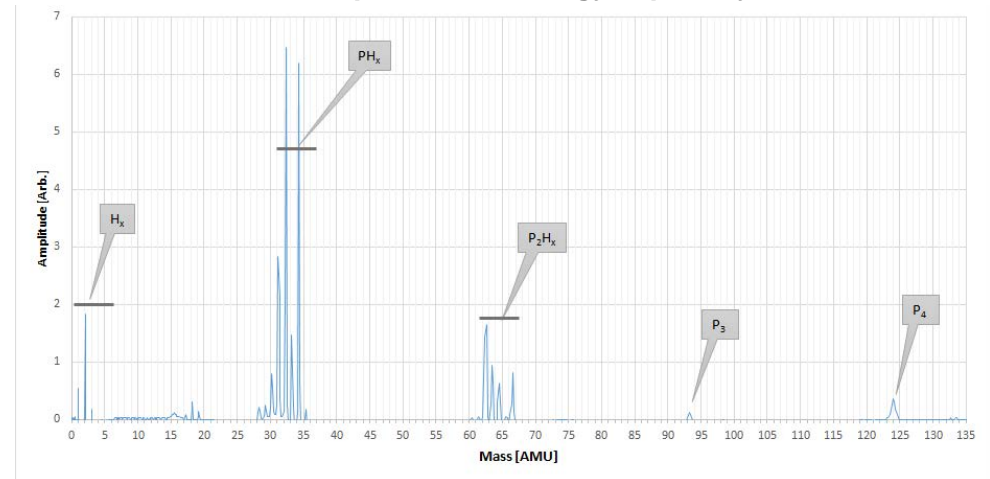
**ENERGi Ion Implant System**  
Fully automated

- Lower in cost than diffusion emitter flow
- Non Mass analyzed source technology
- Running millions of wafers in full production
- Demonstrated multiple Species implantation
  - Phosphorous (PH<sub>3</sub>)
  - Boron (B<sub>2</sub>H<sub>6</sub>, BF<sub>3</sub>, B<sub>2</sub>F<sub>4</sub>)
  - Unique Patented patterning

# Advantageous Atomic profile control



Mixed species and energy capability

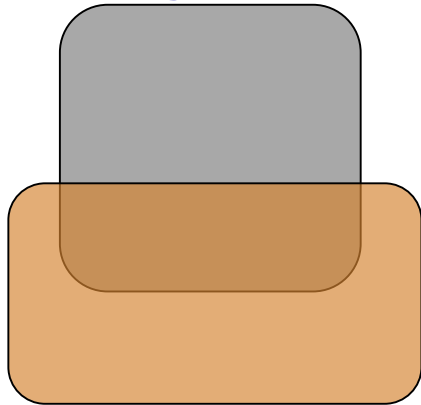


- Implant and anneal parameters impact different parts of the atomic profile.
  - Maximum dose is very near surface dose
  - Surface concentration is almost decoupled from  $x_j$  &  $R_s$
- High dose rate → Full Amorphisation:
  - Complete anneal and activation - SPER
- Tailoring is important to optimize cell parameters
  - For Ag pastes, optimize contact resistance vs Voc

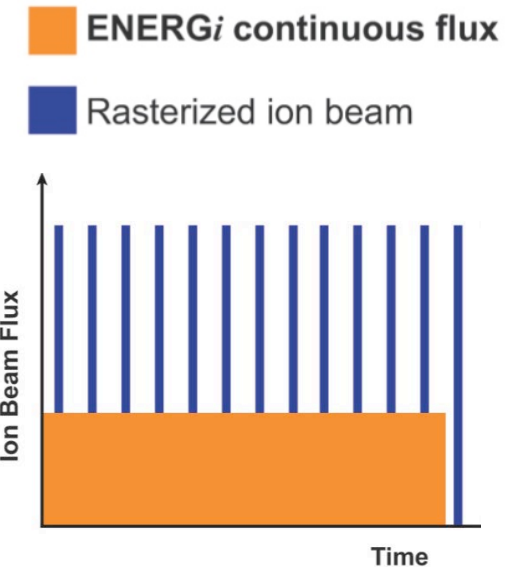
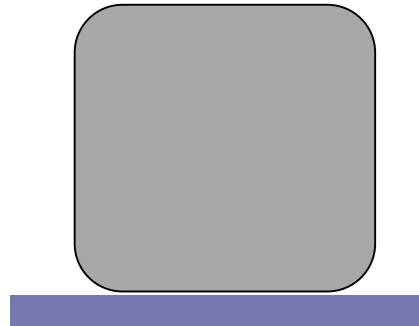
# ENERGi Continuous Flux Implant



**ENERGi  
Continuous Flux  
Single Pass**



**Competitor's  
Multiple Pass  
Systems (6 - 7 times)**

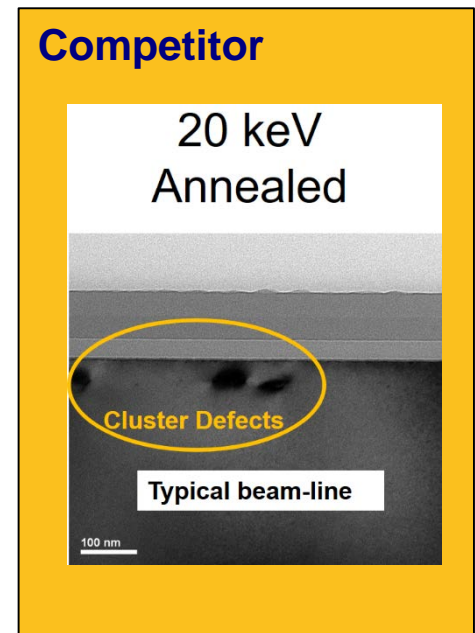
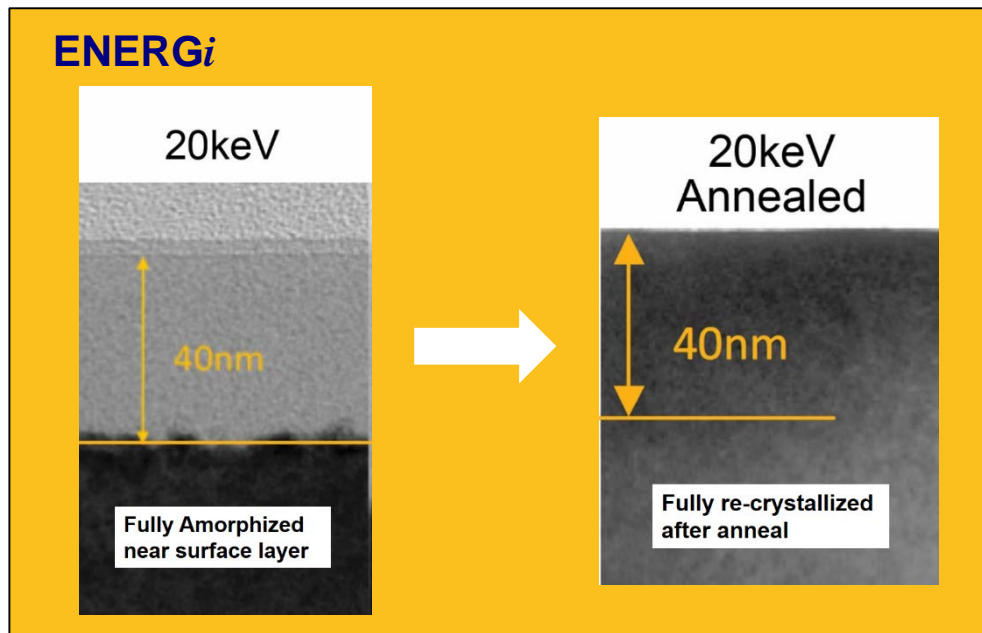


- Dynamic annealing occurs between passes (no beam)
- Single pass helps to fully amorphize and fully anneal

# Near Surface Amorphization and Regrowth



- ENERGi generates fully amorphized near surface layer
  - Due to high dose rate and single pass
  - Good/complete amorphization is desired for best annealing
- This layer will fully re-crystallize during anneal
  - Solid Phase Epitaxial Recrystallization (SPER)

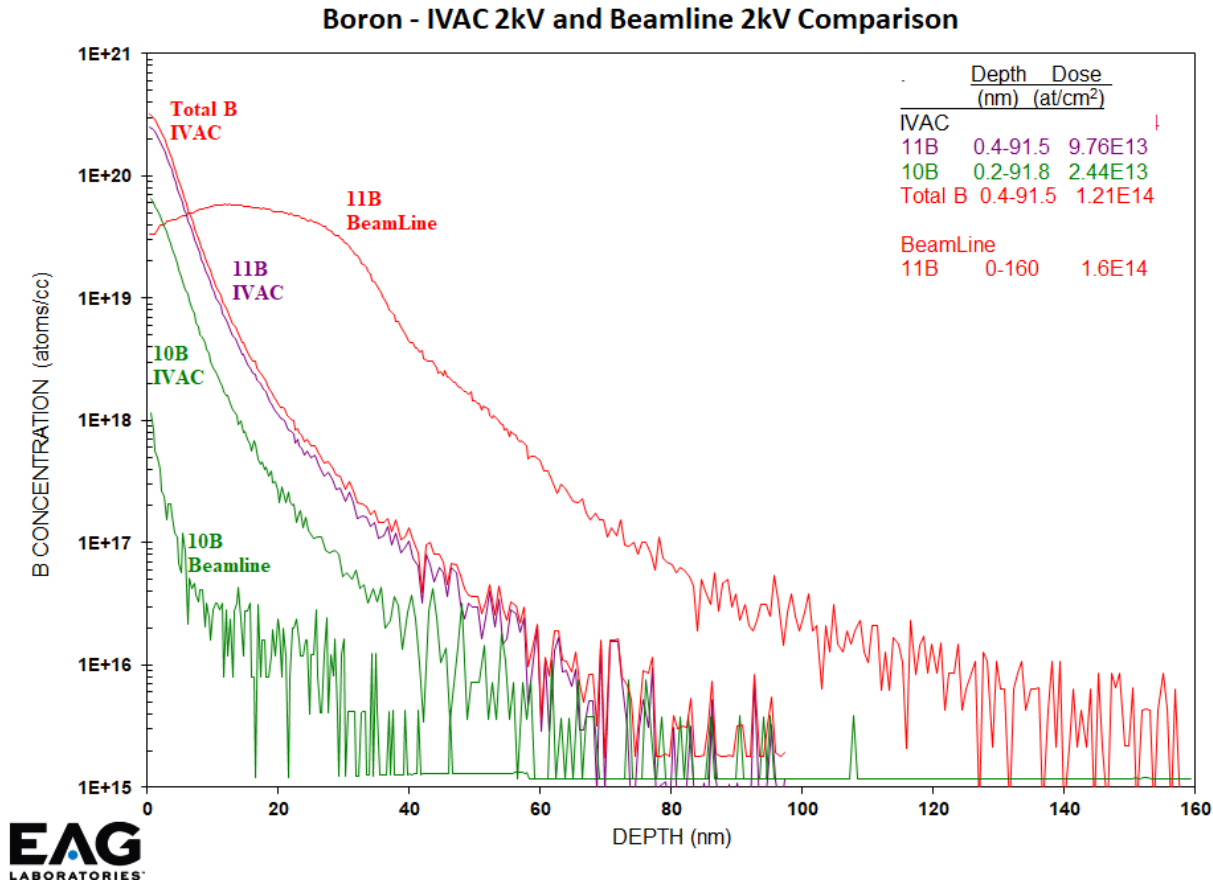


**ENERGi ion implant enables high quality epitaxial regrowth**

# Boron Implant Comparison to Beamline system



- Intevac system used B<sub>2</sub>H<sub>6</sub> at 2kV, Beamline mass analyzed to 11B and 10B
- IVAC profile provides best near surface doping



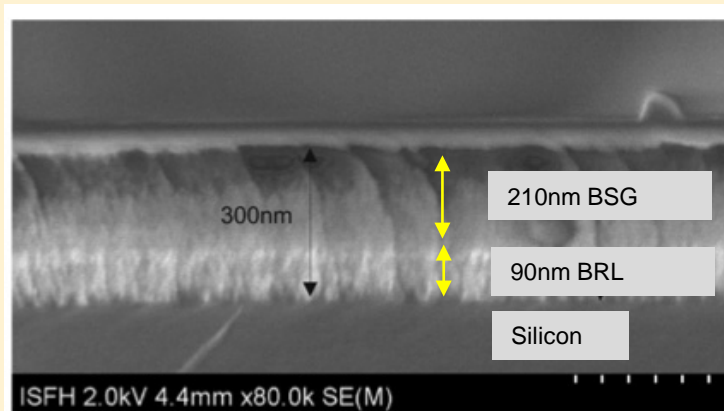


# Boron Implant Advantages



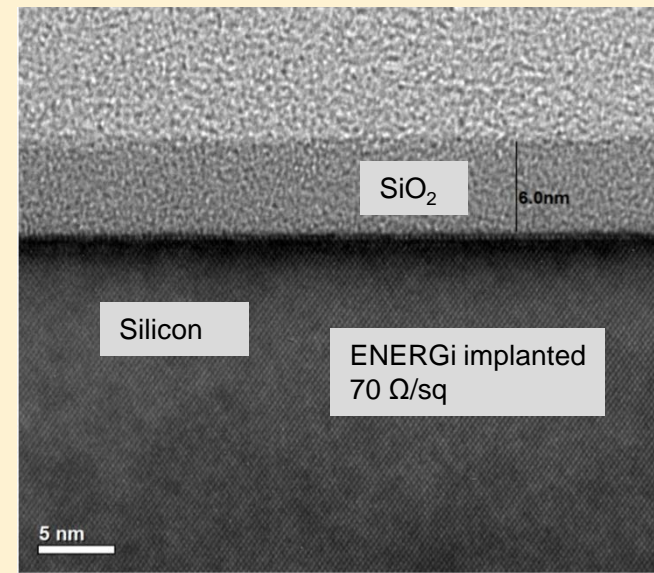
## Diffusion

- Boron Rich Layer (BRL) impact mcl life time
- BSG removal is difficult
- More process steps
- Higher CoO

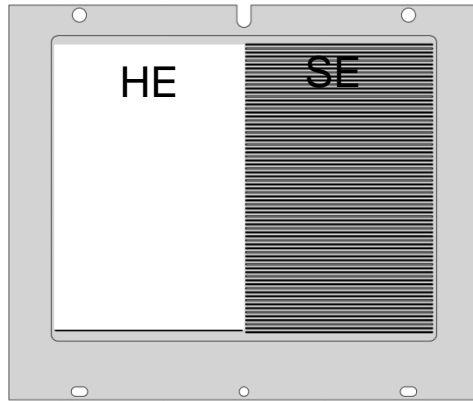


## Implant

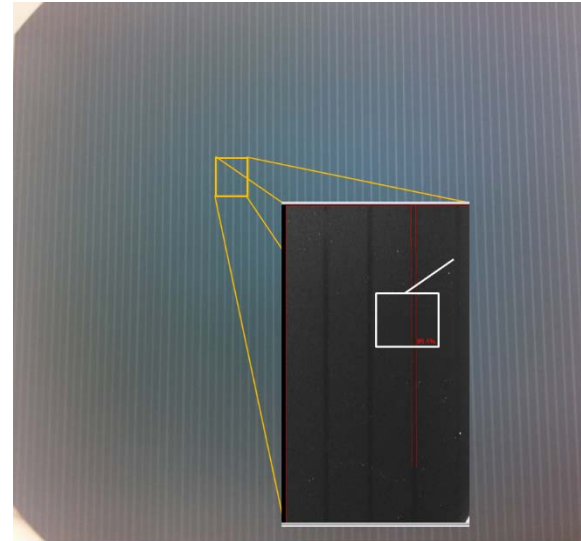
- No Boron rich layer or BSG
- Precise Boron dose
- Superior surface interface & emitter
- Excellent uniformity and repeatability
- Low cost of ownership



# Patterning – Patented Simultaneous HE and SE

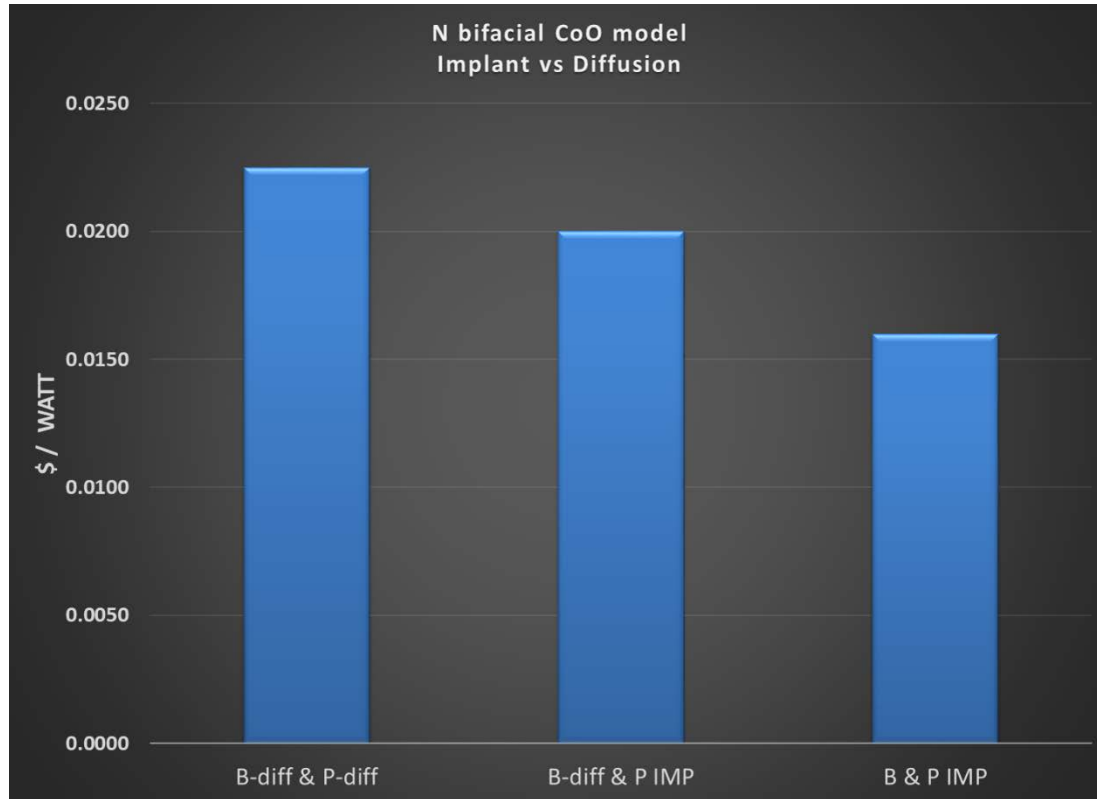


Isothermal Shadow Mask  
Simultaneous Homogeneous  
and Selective Implant



- Using a patented isothermal shadow mask both Selective and Homogeneous implants can be formed
- HE/SE adjustable to match sheet resistance required

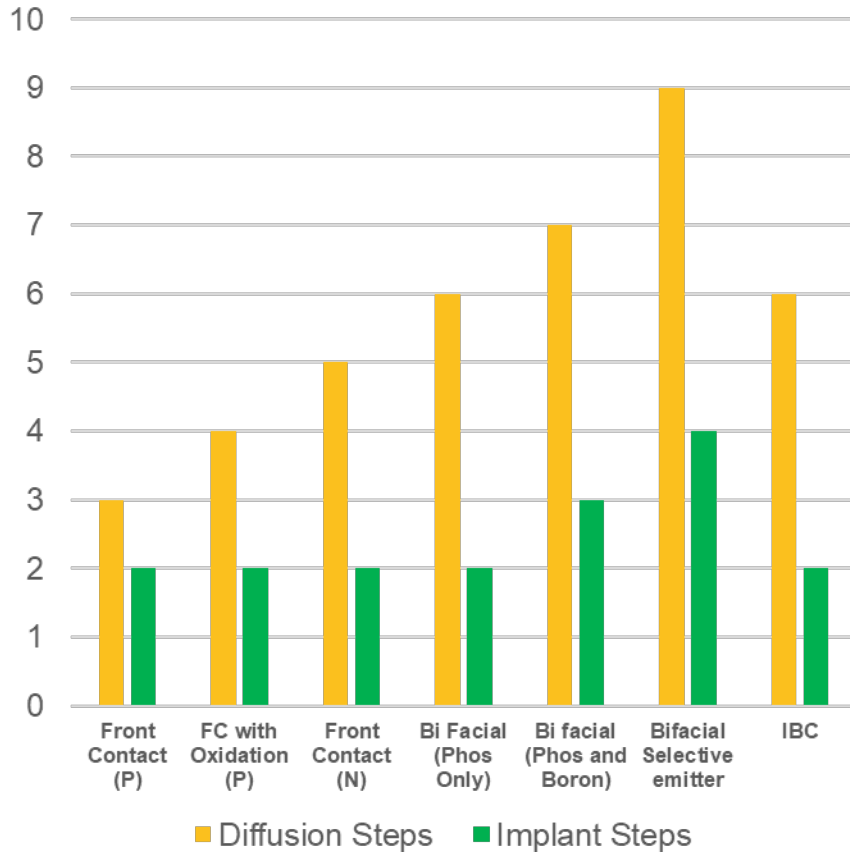
# All Implant Solution for lowest PV Cost



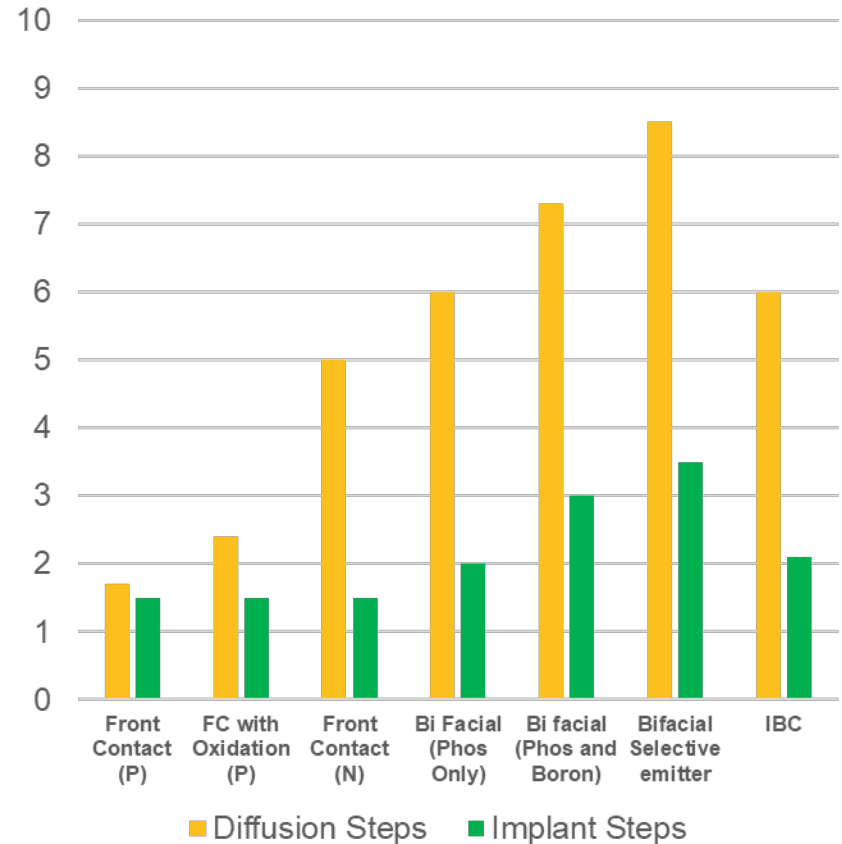
# CoO Advantage in Advanced Cells



### Emitter and BSF Flow Steps Reduction



### Emitter and BSF Cost (Cents/Watt)



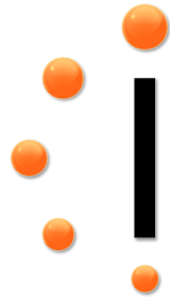
**Ion Implant Cost Savings Improve with Advanced Cells**

# ENERGi - Enabling Ion Implant for Advanced Solar Applications



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  - Unique 1D patterning



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