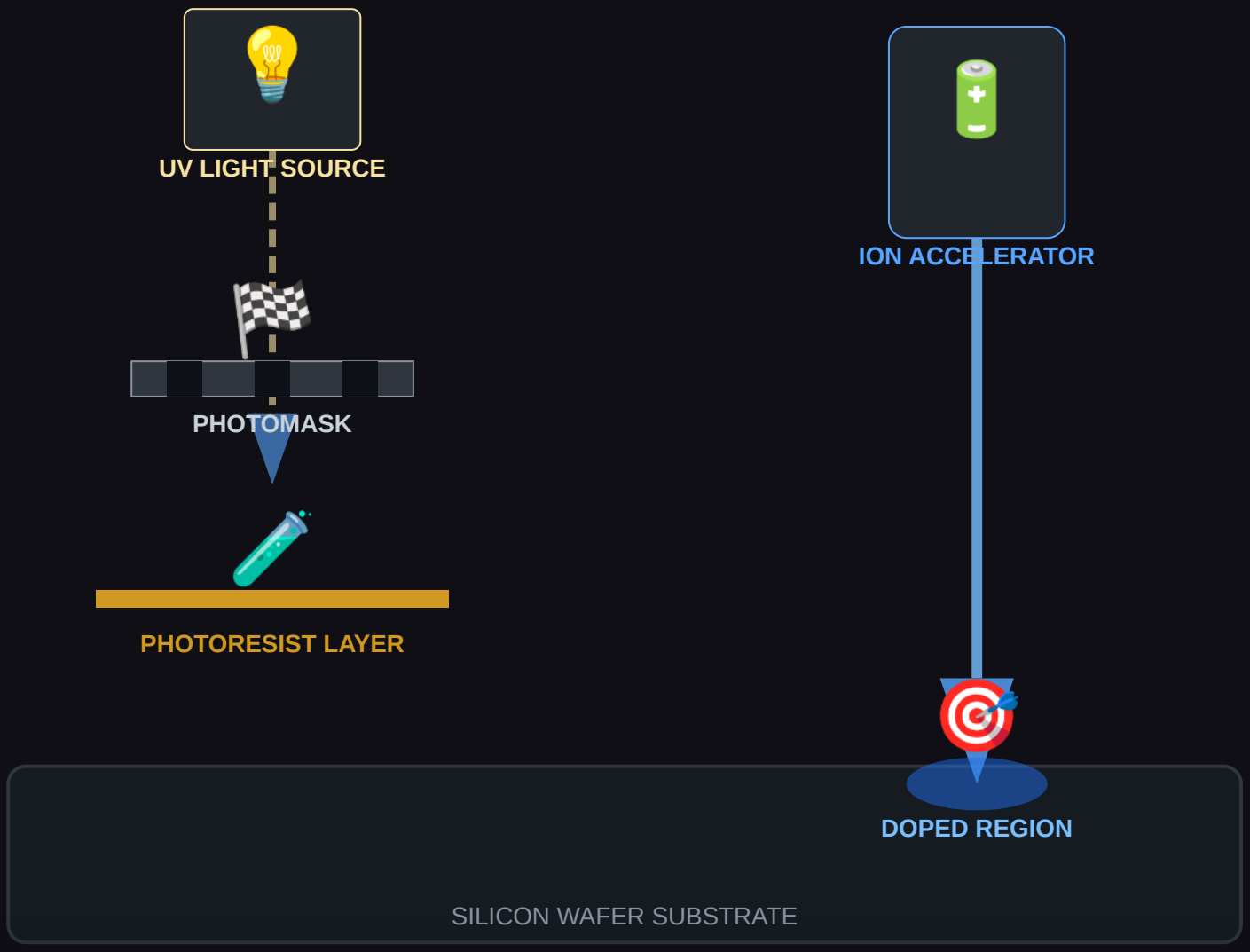

Vectree

Photolithography and ion implantation in semiconductor fabrication

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💡 UV Exposure System

The UV source, often a Deep Ultraviolet (DUV) or Extreme Ultraviolet (EUV) laser, provides the energy required to trigger chemical changes in the photoresist. In modern lithography, EUV light with a wavelength of 13.5nm is used to create incredibly small features.

The light passes through a complex series of mirrors and lenses to ensure uniform intensity across the entire wafer field before hitting the mask.

🏁 The Photomask (Reticle)

A photomask is a master template containing the integrated circuit design. It acts like a stencil, where opaque areas block the UV light and transparent areas allow it to pass through to the wafer.

In high-end manufacturing, ‘Optical Proximity Correction’ (OPC) is applied to the mask design, intentionally distorting patterns to compensate for diffraction effects that occur at the nanometer scale.

🧪 Photoresist Chemistry

The photoresist is a light-sensitive polymer coating. When exposed to UV light, its chemical structure changes.

In ‘positive’ resists, the exposed area becomes soluble in a developer solution, while in ‘negative’ resists, the exposed area becomes polymerized and insoluble. This creates a temporary physical barrier that defines where subsequent etching or implantation will occur.

🔋 Ion Implantation Source

Ion implantation is the process by which dopant atoms (like Boron or Phosphorus) are ionized, accelerated to high speeds using electric fields, and slammed into the silicon substrate.

A mass analyzer (magnet) ensures that only the specific isotope of the desired dopant reaches the wafer, preventing contamination. The energy of the ions determines how deep they penetrate the crystal lattice.

🎯 Crystalline Doping

Once ions are embedded in the silicon, the ‘Doped Region’ is formed. These foreign atoms replace silicon atoms in the lattice, providing extra electrons (N-type) or ‘holes’ (P-type).

Immediately after implantation, the crystal lattice is damaged. A process called ‘Annealing’ (rapid heating) is required to repair the lattice and ‘activate’ the dopants so they can contribute to electrical conductivity.

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