process will be further discussed in this section because of their potential for use in future high-throughput solar cell manufacturing.

12.3.2 RF Glow Discharge Deposition

Figure 12.11 shows a schematic of a typical RF PECVD chamber and related parts. A silicon-containing gas such as a mixture of SiH_4 and H_2 flows into a vacuum chamber that is evacuated by a pump. Two electrode plates are installed inside, and an RF power is applied between them; one option is to ground one of these electrodes. At a given RF voltage across the plates, there is usually a range of gas pressures for which a plasma will occur. The plasma excites and decomposes the gas and generates radicals and ions in the chamber. Various substrates may be mounted on one or both of the electrodes, and thin hydrogenated silicon films grow on the substrates as these radicals diffuse into them. The substrates are heated to achieve optimum film quality; this effect is attributed to thermally activated surface diffusion of adatoms on the growing film.

A PECVD system usually consists of several major parts: (1) a gas delivery system (gas cylinders, pressure regulators, mass flow controllers, and various gas valves to direct gas flows); (2) a deposition chamber that has electrodes, substrate mounts, substrate heaters, and the RF power feed through; (3) a pumping system that usually has a turbomolecular pump backed with a mechanical pump; (4) a pressure control system that has a capacitance manometer, ionization gauges, thermocouple gauges, and/or throttle valve to monitor and control the chamber pressure; (5) an exhaust system for the process gases (typically either with a chemical scrubber to neutralize the gases or with a "burn box" to pyrolyze them). In multichamber systems there is a transfer system to move substrates inside the vacuum system between various deposition chambers through appropriate gate valves. Many of these elements are connected to an instrument control panel that contains an RF power supply, impedance matching box, and readouts or controllers for the vacuum gauges, mass flow controllers, throttle valves, pneumatic valves, and turbomolecular pumps.

The film growth in a PECVD process consists of several steps: source gas diffusion, electron impact dissociation, gas-phase chemical reaction, radical diffusion, and deposition [60, 61, 74]. To deposit good-quality a-Si films, the deposition conditions need to be

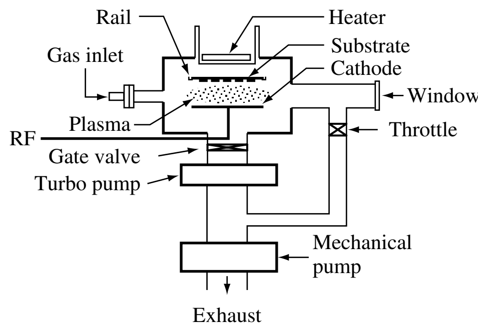

Figure 12.11 Schematic of a typical RF glow discharge deposition chamber