CHAPTER 3

SYSTEM CONFIGURATION

The major components of the RF-PECVD system consist of vacuum parts, gas feed control parts, power transfer parts, and diagnostic parts [4,5,6,7]. Figure 3.1 shows the schematic diagram of the major components of the RF-PECVD system.

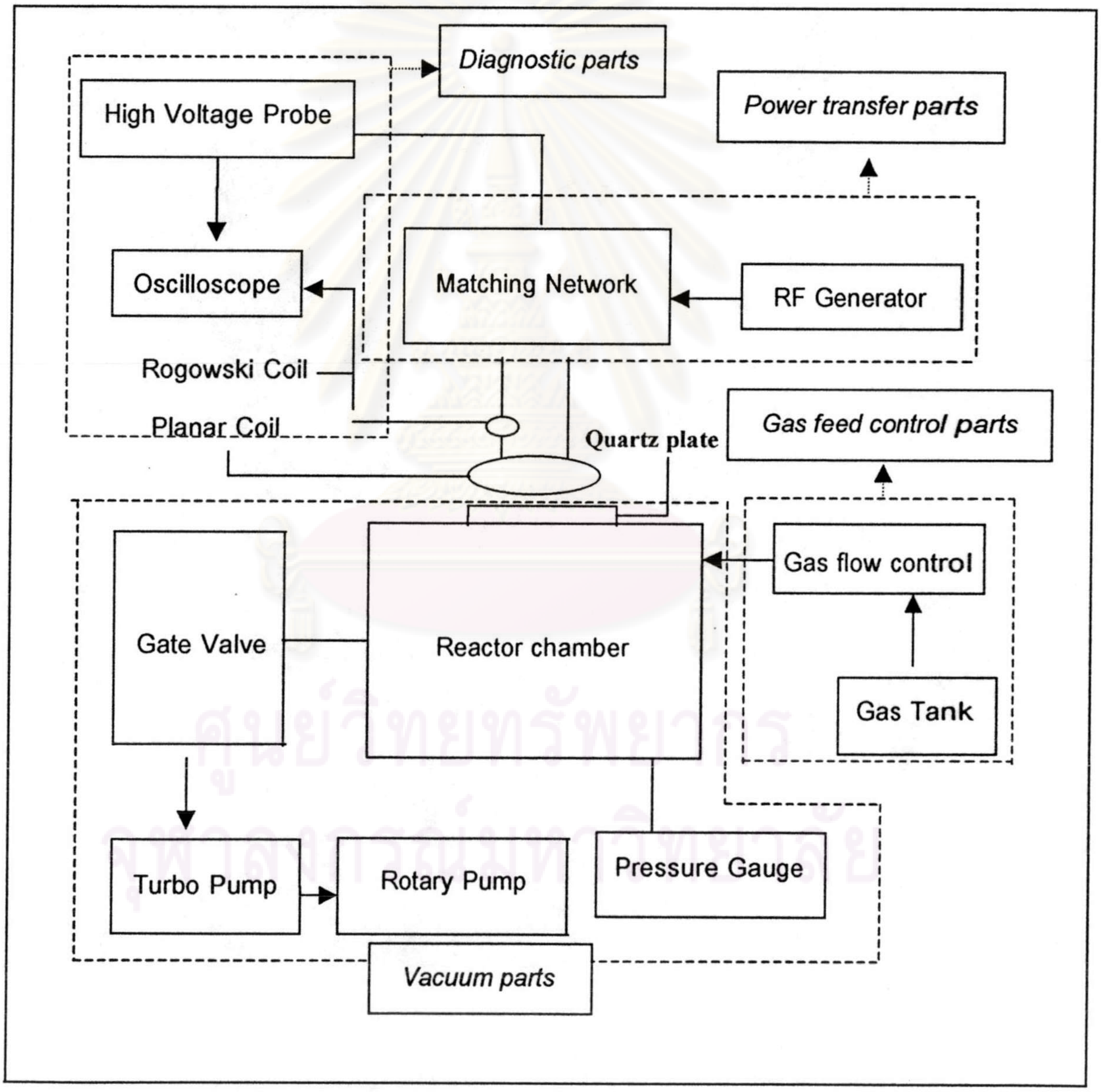

Figure 3.1: Schematic diagram of the system configuration

There are several research group bult and set-up the RF ICP system. El-Fayoumi, et.al., used the RF system to study the properties of argon plasma. Kortshagen, et.al., built the RF ICP system to the E-H mode transition in RF inductive discharge. Liew studied the characteristic of RF system for application. One application of RF system, Liew has utilized RF system for coating TiN on the Ti-plate. However, it is noticed that most system consists of major parts as will be described below

The vacuum parts consist of a reactor chamber, gate valve, quartz plate, a rotary pump, a turbomolecular pump pirani gauge and inverted magnetron gauge. Quartz plate used as a dielectric window that allows the electromagnetic fields to transmit through. Gas feed control parts consist of gas flow control and gas tank. Power transfer parts consist of RF generator, planar coil and matching impedance network. Diagnostic parts consist of Rogowski coil, high voltage probe and an oscilloscope.

Vacuum parts are used in this thesis because plasma can only be generated in appropriate pressure. Gas feed control parts act as valve is used to control gas flow rate. Power transfer parts consist of RF generator and matching network acts as electric fields source while diagnostic parts are used to study characteristics of RF-PECVD system.

The RF-PECVD system procedures are divided into two operations process, vacuum operation and power transfer operation. Details of vacuum operation is described in chapter 4 and power transfer operation is described in chapter 5.

3.1 Advantages of RF-PECVD system

A small planar coil ICP system set-up by Thien Voon Kwan [7], located the planar coil below the quartz plate at the bottom of reactor chamber. Schematic diagram of a small planar coil ICP system set-up by the author is shown in Figure 3.2. Liew [13] has developed the same system to prepare diamond-like carbon thin films.

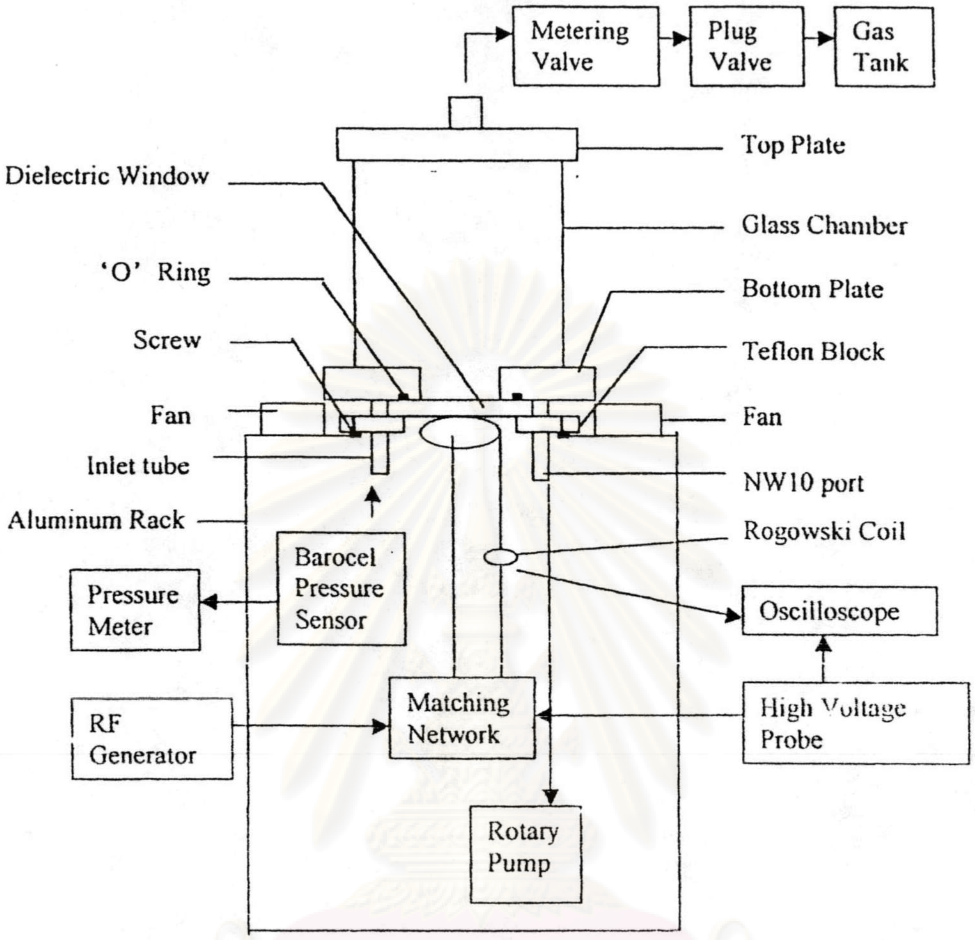

Figure 3.2: Schematic diagram of the small planar coil ICP system [7]

Alexandrov and Kovalgin [14] set up a Remote Plasma Chemical Vapor Deposition (RPECVD) of Silicon Nitride Films system. Their RPECVD system is shown in Figure 3.3. RF coil located at the top of reactor chamber. This system is reported to develop good quality of silicon nitride films.

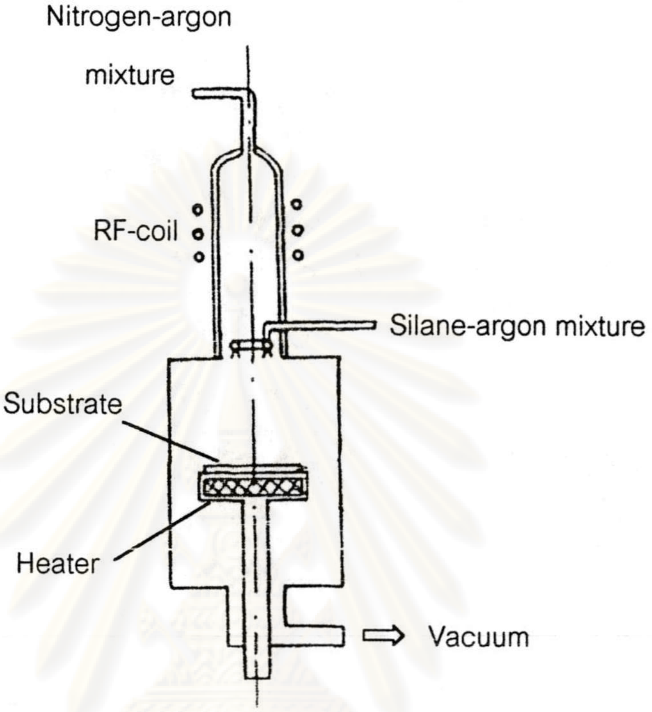

Figure 3.3: Schematic diagram of the RPECVD system [14]

In this thesis, we focus on the development and set-up of inductively coulped planar coil RF-PECVD system. This system use a planar coil as a conductor and place it over the quartz plate at the top of reactor chamber not inside the chamber. This results in less contaminated thin-film growth process. Another advantage of this planar coil design is that it can generate a disk like uniform plasma. Planar coils, used in ICP system come in many shapes [15] as shown in Figure 3.4

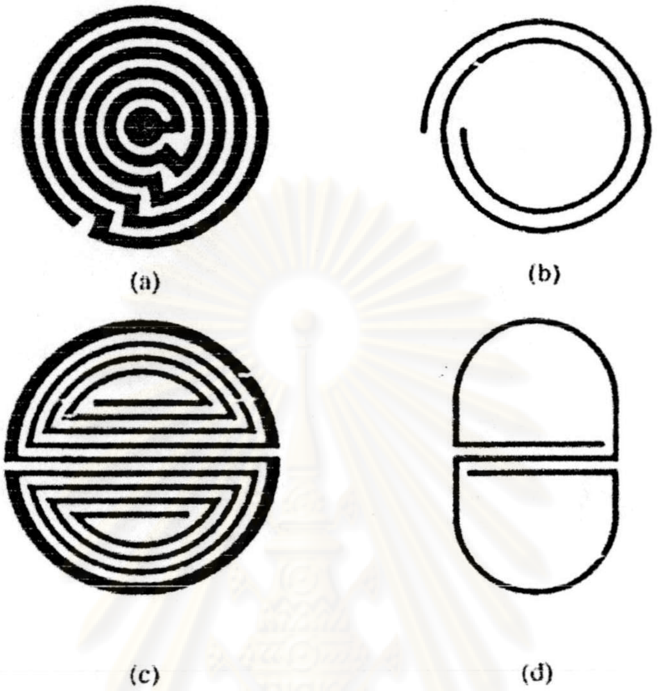

Figure 3.4: (a) full spiral coil, (b) truncated spiral coil, (c) complex butterfly coil, and (d) truncated butterfly coil.

The coils in Figure 3.4 are designed for high radio frequency plasma sources. The full spiral coil (Figure3.4(a)), currently the standard for flat coil work, provides fairly good power transfer, but a plasma shape may produce less central film growth that can be inconvenient for processing applications. The butterfly coils (Figure3.4(c)), produce more useful ICP by moving the hole off center.

The shape of the plasma, produced by a given coil, follows the pattern of the coil currents. Even at modest distance from the plane of the coil (on the order of the window thickness etc.). However, cancellation of field prevents efficient formation of a bright plasma. It is evident from their comparative studies that small coil loops, as found in coil (a) and (c), noy only do not produce plasma, they inhibit it. They reported that the extra turns in the longer (full) coil make a more spatially homogeneous glow than the truncated coils. For efficient power coupling to the plasma, the formation of closed plasma current loops is necessary.