

## MEMS Fabrication & Design HW#1

**Question) What are the origins of pressure units and their equivalency?**

**Answer)**

### **1) Origin of pressure units.**

① Torr: Torricelli attracted considerable attention when he demonstrated the first mercury barometer to the general public. He is credited with giving the first modern explanation of atmospheric pressure. Scientists at the time were familiar with small fluctuations in height that occurred in barometers. When these fluctuations were explained as a manifestation of changes in atmospheric pressure, the science of meteorology was born.

Over time, 760 millimeters of mercury came to be regarded as the "standard" atmospheric pressure. The unit of barometric pressure (one millimeter of mercury, also written as 1 mm Hg) was named in honor of Torricelli.

② Pa: This SI unit is named after Blaise Pascal. As with all SI units whose names are derived from the proper name of a person, the first letter of its symbol is uppercase (Pa). When an SI unit is spelled out in English, it should always begin with a lowercase letter (pascal), except for at the beginning of a sentence or in capitalized material such as a title.

③ PSI: PSI means the pound per square inch or, more accurately, pound-force per square inch (symbol: psi or lbf/in<sup>2</sup> or lbf/in<sup>2</sup>), which is a unit of pressure or of stress based on avoirdupois units. It is the pressure resulting from a force of one pound-force applied to an area of one square inch. It is usually used in noting pressure of tire.

④ atm: Standard atmosphere is a pressure defined as 101,325 Pa and used as unit of pressure (symbol: atm). Standard atmosphere is a non-SI unit that is internationally recognized. The 10th Conférence Générale des Poids et Mesures (10th CGPM) adopted standard atmosphere for general use and affirmed its definition of being precisely equal to 1,013,250 dynes per square centimeter (101,325 Pa). This value is intended to represent the mean atmospheric pressure at mean sea level at the latitude of Paris, France, and as a practical matter, truly reflects the mean sea level pressure for many of the industrialized nations (those with latitudes similar to Paris).

In chemistry, the original definition of "Standard Temperature and Pressure" (STP) was a reference temperature of 0°C (273.15 K) and pressure of 101.325 kPa (1 atm). However, in 1982, the International Union of Pure and Applied Chemistry (IUPAC) recommended that for the purposes of specifying the physical properties of substances, "the standard pressure" should be defined as precisely 100 kPa ( $\approx$ 750.062 Torr).

## 2) Equivalency among pressure units

	<b>pascal (Pa)</b>	<b>bar (bar)</b>	<b>technical atmosphere (at)</b>	<b>atmosphere (atm)</b>	<b>torr (Torr)</b>	<b>pound-force per square inch (psi)</b>
<b>1 Pa</b>	$\equiv 1 \text{ N/m}^2$	$10^{-5}$	$1.0197 \times 10^{-5}$	$9.8692 \times 10^{-6}$	$7.5006 \times 10^{-3}$	$145.04 \times 10^{-6}$
<b>1 bar</b>	100,000	$\equiv 10^6 \text{ dyn/cm}^2$	1.0197	0.98692	750.06	14.504
<b>1 at</b>	98,066.5	0.980665	$\equiv 1 \text{ kgf/cm}^2$	0.96784	735.56	14.223
<b>1 atm</b>	101,325	1.01325	1.0332	$\equiv 1 \text{ atm}$	760	14.696
<b>1 torr</b>	133.322	$1.3332 \times 10^{-3}$	$1.3595 \times 10^{-3}$	$1.3158 \times 10^{-3}$	$\equiv 1 \text{ Torr};$ $\approx 1 \text{ mmHg}$	$19.337 \times 10^{-3}$
<b>1 psi</b>	6,894.76	$68.948 \times 10^{-3}$	$70.307 \times 10^{-3}$	$68.046 \times 10^{-3}$	51.715	$\equiv 1 \text{ lbf/in}^2$