crucible of Sn or a Sn-containing compound. As the crucible temperature increases, the vapor pressure of Sn in the crucible increases and Sn vapor deposits on a substrate. CVD is a similar technique except the dopant source is a volatile Sn compound and will react with the substrate when deposited therein.

[0006] For example, mixtures of $Sn(CH_3)_4$ with either CF_3I or CF_3Br compounds can be co-deposited with O_2 at elevated temperatures on a heated substrate to produce films of SnO_2. Sn can also be embedded in the surface of a substrate using ion implantation. In one method of ion implantation, Sn metal is placed in close proximity to a filament and the temperature of the filament is high enough that radiative heating causes Sn to evaporate and collide with electrons to create Sn ions for doping. However, this method can cause Sn to deposit on the chamber walls or on the filament, shortening the filament lifetime.

[0007] There is no currently viable Sn dopant source available today for ion implantation. For these reasons, there is an unmet need for a Sn dopant source that can be used in traditional ion implantation systems.

Summary of the Invention

[0008] The invention relates, in part, to certain tin dopant sources that are stable at room temperature, have sufficient vapor pressure and are capable of producing a sufficient beam current for ion implantation. The dopant source is preferably delivered in sub atmospheric conditions to enhance the safety and reliability during tin ion implantation.

[0009] In a first aspect, a method for using Sn containing dopant material for an ion implantation process, comprising the steps of: storing a Sn containing dopant source in a storage and delivery container; the Sn-containing dopant source characterized ~~by one or more~~all of the following attributes: (i) stability during storage and delivery; (ii) a vapor pressure of greater than or equal to 20 Torr at room temperature (25°C); (iii) ~~generation of an ion beam capable of doping greater than 10^{11} atoms/cm^2; (iv) naturally occurring~~existing as a liquid at room temperature; and (iv) comprising Sn~~, H~~ and a ~~halogen~~ carbon atom; withdrawing the Sn containing dopant source in the vapor phase from the storage and delivery container; flowing the vaporized the Sn containing dopant

source; and introducing the Sn-containing dopant source vapor to an ion source chamber.

[0010] In a second aspect, a source supply for a Sn dopant gas composition comprising: a Sn-containing dopant source characterized by ~~one or more~~all of the following attributes: (i) stability during storage and delivery; (ii) a vapor pressure of greater than or equal to 20 Torr at room temperature (25°C); (iii) ~~generation of an ion beam capable of doping greater than 10^{11} atoms/cm^2; (iv) naturally occurring~~existing as a liquid at room temperature; and (iv) comprising Sn~~, H~~ and a ~~halogen~~ carbon atom; a delivery and storage device for maintaining the Sn-containing dopant source in a pressurized state within an interior volume of the device, said delivery device in fluid communication with a discharge flow path~~, wherein said delivery device is actuated to allow a controlled flow of the Sn-containing dopant source from the interior volume of the device in response to a sub-atmospheric condition achieved along the discharge flow path~~.

[0011] In a third aspect, a Sn-containing dopant composition for use in an ion implantation process, comprising: a Sn-containing dopant ~~gas~~ source material~~, source~~ characterized by ~~one or more~~all of the following attributes: (i) stability during storage and delivery; (ii) a vapor pressure of greater than or equal to 20 Torr at room temperature (25°C); (iii) ~~generation of an ion beam capable of doping greater than 10^{11} atoms/cm^2; (iv) naturally~~ existing as a liquid at room temperature; and (iv) comprising Sn~~, H~~ and a ~~halogen~~ carbon atom.

Brief Description of the Drawings

[0012] The objectives and advantages of the invention will be better understood from the following detailed description of the preferred embodiments thereof in connection with the accompanying figures wherein like numbers denote same features throughout and wherein:

[0013] Figure 1 is a schematic of a beamline ion implant system for implanting Sn in accordance with the principles of the present invention;

[0014] Figure 2 is a schematic of a plasma immersion system for implanting Sn in accordance with the principles of the present invention;