LABORATORY GROWN DIAMONDS- How do they differ from natural ones?: A scientific Perspective

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Diamond can be formed in nature only under high pressure and high temperature (HPHT) conditions that exist deep inside the earth; typical pressure and temperatures being in the range of 10Gpa and 1800 to 2000C respectively. Carbon would exist as graphite at lower pressures and temperatures. The triple point at which graphite, diamond and a molten concoction of carbon can coexist is around 5000K and 12 GPa. Diamond is thermodynamically unstable at room temperature for any value of pressure and synthesis of diamond from graphite requires the creation of the HPHT conditions conducive for stable diamond phase in the laboratory. The synthesis involves the dissolution of graphite in to molten iron and crystallization under suitable HPHT conditions using a diamond seed crystal. The first successful attempts of HPHT synthesis were by Swedish General Electric Company; the first patent for the HPHT process was by American General Electric Company (GE) in 1955. The high pressure conditions were achieved using four anvils in tetrahedral geometry. The pressure and temperature conditions were 100,000 atmosheres and 1600C respectively. In the recent past it is shown that diamonds can be grown under low pressure and low temperature conditions using chemical vapour deposition (CVD) route which is epitaxial growth of diamonds on a suitable substrate. This made a lot of scientific applications possible of CVD grown diamond films.

The impact of developments in science and technology of laboratory grown diamonds on Gem & Jewellery Sector and natural diamond trade would depend critically on our ability to detect lab grown diamonds both as loose stones and studden in jewellery.

Whereas it is rare to have natural diamonds with attractive colours, HPHT synthetics can be produced in attractive/vivid colours.

By CVD process type-IIa diamonds can be produced which are relatively less abundant in nature. With proper post growth thermal treatment (LPHT or HPHT) type IIa diamonds of excellent quality can be produced. It is also possible to produce blue coloured CVD diamonds by incorporating boron during growth process. Again, such crystals are extremely rare in nature. Using the present day technology all these diamonds can be grown to sizes more than one carat and it offers great new opportunities in Gem& Jewellery sector.

Many applications exist for lab grown diamonds in electronics industry, chemical sensors, UV and high energy radiation detection etc, for which most of the natural diamonds are not amenable. This offers a multi pronged opportunity for lab grown diamond industry. Present

talk would deal with the detection of synthetic diamonds by spectroscopic methods and also some scientific applications of CVD diamonds.

Spectroscopic Methods of Identifying Lab grown diamonds:

The developments in laboratory production of diamonds can be converted in to an opportunity only if there is a sound and robust scientific methodology for distinguishing the natural diamonds from laboratory grown ones either by HPHT or CVD routes. In what follows we give the details of methods followed in our laboratory and many other laboratories. The methods used are : 220nm- UV excited fluorescence mapping using 'Diamond View', Laser Raman & laser excited Photo Luminescence, Fourier Transform Infrared (FT-IR) spectrometry, Uv-Visible absorption and X-ray Fluorescence(XRF) and 2D-XRF mapping.