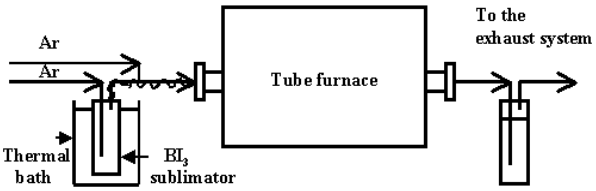

Figure 3. Schematic of the CVD apparatus.

To verify that H_3BO_3 is produced by exposing BI_3 powder to humid air, 0.5g of BI_3 powder is exposed to air (30% relative humidity and 23˚C) for more than 20 hours. X-ray diffraction (XRD, a Rigaku 2-circle diffractometer with Cu Kα radiation) is used to analyze the reaction product.

When BI_3 powder is exposed to air (30% relative humidity and 23ºC), the faintly red powder of BI_3 slowly loses its color. At the same time, a lot of gas comes out of the surface. After more than 20 hours, the BI_3 powder turns into a white powder, with some brown deposition around the container in which the powder is located. Figure 4(a) shows a XRD pattern taken from the white powder, while Figure 4(b) shows a XRD pattern from H_3BO_3 powder (99.999%, Aldrich). The great similarity between the two suggests that the white powder is H_3BO_3. It is well known that BI_3 reacts with water violently to form H_3BO_3 and HI[16]. HI is a gas at room temperature and reacts with O_2 to form H_2O and I_2[16]. After a long reaction time (more than 20 hours), all the BI_3 powder turns into H_3BO_3 and I_2. Solid iodine is quite volatile even at room temperature[16], so what is left is mainly H_3BO_3 powder. If the exposure time of BI_3 powder is short, for example 5 minutes, the originally pure BI_3 powder turns into a mixed powder of H_3BO_3, I_2 and BI_3. Since I_2 is volatile, the main composition of the mixed powder would be H_3BO_3 and BI_3. Both H_3BO_3 and BI_3 have high vapor pressure at relatively low temperature, so it is

reasonable to believe that the vapor from the sublimator that contains BI_3/H_3BO_3 powder is composed of BI_3 and H_3BO_3 vapor.

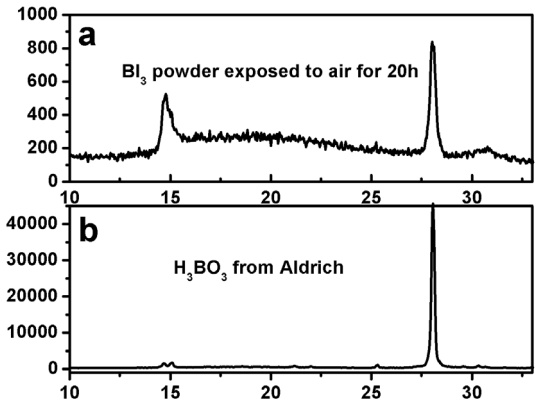

Figure 4(a) XRD pattern taken from the BI_3 powder exposed to air (30% relative humidity, 23˚C) for more than 20 hours. (b) XRD pattern from H_3BO_3 powder (99.999%, Aldrich).

To see if $Mg_2B_2O_5$ nanowires can be produced using either pure BI_3 or pure H_3BO_3 powder as the sublimate source, BI_3 or H_3BO_3 (99.999%, Aldrich), instead of the mixed powder of BI_3/H_3BO_3, is placed in the sublimator. BI_3 is transported into the sublimator inside a glove box to prevent it from reacting with H_2O vapor and O_2 in air. The CVD deposition process and the structure characterization processes are then repeated. The results show that no nanowires are produced using pure BI_3 or pure H_3BO_3 powder as the sublimate source.

The device fabrication process is described briefly as following. $Mg_2B_2O_5$ nanowires are first dispersed in isopropyl alcohol by sonication and then deposited onto a degenerately doped p-type silicon substrate capped with 500 nm oxide layer ((100), Silicon Valley Microelectronics). Coordinate markers are predefined on top of the SiO_2 layer to mark the relative positions of the nanowires. Bilayer electron beam resists (PMMA&MMA/MAA) are spun onto the substrate, and the contact electrode patterns are

exposed by a JEOL electron beam writer operated at 50 KeV. After developing, Au/Ti (10 nm/110 nm thick) contacts to the nanowires are metallized by electron beam evaporation. Figure 5 shows an AFM (Digital Instrument, Multimode SPM) image of a nanowire with two contact electrodes. The nanowire channel length between the electrodes is 1.28 μm. To improve the electrical contact, the sample was further loaded into a 10^{-2} torr vacuum chamber and annealed for 1 hour at 500°C. But no essential change of conductance is observed.

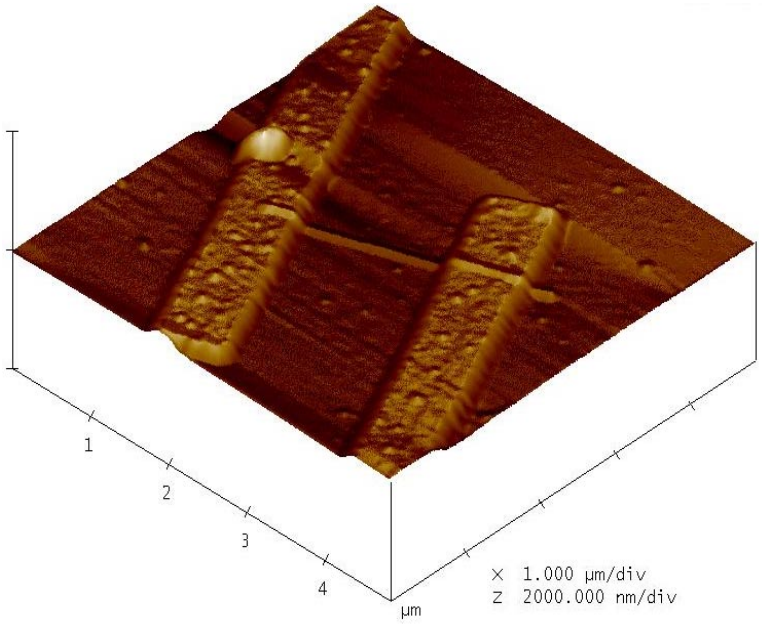

Figure 5. AFM image of a $Mg_2B_2O_5$ nanowire contacted with Au/Ti electrodes. The diameter of the nanowire is 36 nm and the channel length between electrodes is 1.28 μm.

Reference:

16. Holleman, A. F.; Wiberg, E. Inorganic Chemistry; Academic Press, 2001.