DESIGN AND FABRICATION OF SEMI-AUTO WAFER SCRIBER FOR 4-IN AND 8-IN WAFERS

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DECLARATION

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ABSTRACT

High demanding in semiconductor on wafer make fabrication of wafer keep increase years by years. Before a semiconductor device can be built, silicon must turn into a wafer which begins the growth of silicon ingot. Polysilicon crystal that formed by many small single crystals came with different orientations which required functionality which involves different steps during manufacturing. Orientation is known as line/direction when silicon wafers are slice from crystal. Die separation of thin silicon wafers and delicate substrates creates challenges for traditional saw dicing**.** Scribe and break die separation is an alternative to saw dicing. The feature of scribe need beneficial with thin silicon wafers which is hard and brittle material. To break the wafer, a scribe line must be created in the wafer surface where the break is desired**.** There are many type of diameter of wafer. This prototype is cover for 4 inch and 8 inch diameter of wafers. Design of wafer scriber being done by considering some parameter which is material, functional of every parts and machining process. Fabrication of prototype is done by considering design and machining processes. A sample of scriber is chosen for analyzing result of line scribe using scanning electron microscopy technique (SEM). The sample is analyzed by comparing width of line scribe with tip diameter of scriber. Results of scribe line does not have much different with diameter of tip and there is no crack happened on scribe line.

ABSTRAK

Permintaan yang tinggi dalam industri semikonduktor terhadap wafer menyebabkan pembuatan wafer kian meningkat dari tahun ke tahun. Sebelum pembuatan sesuatu peralatan semikonduktor, silikon mestilah dijadikan sebagai wafer dimana permulaan pertumbuhan ingot silikon. Bahagian terkecil bagi sesuatu hablur yang akan membentuk keseluruhan struktur hablur berkenaan terdiri daripada beberapa orientasi yang berlainan yang mana memerlukan fungsi yang tertentu melibatkan langkah-langkah yang berbeza semasa proses pembuatannya. Orientasi dikenali sebagai garisan/arah apabila wafer silikon dipotong dari hablur. Acuan pemisah silikon wafer yang nipis dan substrat halus mewujudkan cabaran terhadap gergaji secara tradisional. Kikis dan patahkan acuan pemisah merupakan pilihan kepada gergaji. Ciri-ciri scribe mestilah memberi manfaat kepada wafer silikon dimana ia bersifat keras dan rapuh. Untuk mematahkan sesuatu wafer, garis gurisan mestilah dibuat di sepanjang permukaan wafer. Terdapat pelbagai saiz garis pusat sesuatu wafer. Prototaip ini meliputi saiz garis pusat 4 inci dan 8 inci. Reka bentuk penguris wafer dilakukan dengan mempertimbangkan beberapa parameter iaitu bahan, fungsi setiap bahagian dan proses pemesinan. Sampel gurisan dipilih untuk dianalisis hasil garis gurisan menggunakan Scanning Electron Microscopy machine (SEM). Sampel gurisan dianalisis dengan membandingkan lebar garis gurisan dengan saiz garis pusat mata penguris. Hasil garis gurisan tidak menunjukkan perbezaan yang ketara di antara saiz garis pusat mata penguris dengan kelebaran garis gurisan diatas permukaan wafer dan tiada berlaku rekahan di garis gurisan.

CHAPTER1: INTRODUCTION

OVERVIEW OF STRUCTURE OF PROJECT

New modern world nowadays which we can see that economics and institutions emerged, become more sophisticated requiring advance technology in helping on daily basis life. Every technology required an electricity to be functional. That’s why semiconductors became important and had major impact to this world. Back to history, the first semiconductor device manufacturing had spreaded from Texas to California in 1960s [13]. Years by years, Intel became the world largest manufacturer of semiconductor; follow by other company like Taiwan Semiconductor Manufacturing Company, United Microelectronic Corporation and Analog Device [14]. Semiconductor is type of materials that has electrical properties in the middle between conductor and an insulator. One of the parts in semiconductor device is integrated circuit or monolithic integrated circuit which refers as IC, chip or microchip. This part is made from wafer. Wafer is known as slide/substrate which is thin slice of semiconductor material. Usually, wafer been used in fabrication of integrated circuit and other micro devices. Wafer been served as substrate that built it microelectronic devices. There are few processes need to go through before built in as microelectronic devices which are ion implantation, etching, deposition of various materials and photolithography patterning.

There are different steps during manufacturing silicon wafers where conditions of the wafer can be modified to change the overall makeup of the wafer depending on the required functionality of the silicon wafer. Silicon wafer orientation is known as surface aligned in several directions when sliced from crystal. It is important for the electronic properties of the wafer. Path for transport is depending on the ion implantation depths. [15]

Singularity is perceived by few techniques to become small particles. By using traditional saw dicing it became one of challenge for die separation of thin silicon wafer because high-pressure from saw can easily break the wafer. One of techniques called “scribe and break”. This technique more beneficial with thin silicon wafers. Usually before wafer being cut into its die, it needs to scribe first using diamond scriber or laser. Scriber is must so that less physical energy can be applied when cutting the wafer into its die. Scribe line should be created on the surface of wafer because it creates stress concentration factor so that it became easier to break. There are two methods for break which is static bending and impact bending. Static bending usually used by machine or by hand while for impact bending it requires an impact or shock to wafer but it may cause damage to the wafer. With using knowledge on conceptual design and machining knowledge, fabrication of semi-auto wafer scriber for 4-inch and 8-inch wafers can be done.

1.2 AIMS/GOALS OF PROJECT

1. Able to design and fabricate low cost semi-auto wafer scriber for 4-inch and 8-inch wafers prototype.
2. Able to apply engineering knowledge by using suitable process machining and material
3. To get analyze result using wafer scriber prototype.

1.3 PROBLEM STATEMENT

Wafer scribing need high stress concentration on the wafer and it depend on sharpness of scriber tip. Depth of cut is not as important as sharpness of cut. School of Mechanical does not provide prototype scriber for wafer which required high cost. In NFM lab usually student is doing scribing manually just using scriber only without proper place to do. When breaking the wafer, it tends to breaks not following specification as desired which need scribing process to be reduce and waste will happen.

1.4 SCOPE OF PROJECT

Silicon wafer are available in variety diameter sizes from 1-inch to 17.7-inch. Sizes of diameter keep increased which related to the trends; growing chip size, growing demands for chips and a greater chip throughput. But for this project, the fabrication focuses on the design for 4-inch and 8-inch wafer only. This is because this size are frequently use in NFM lab. This prototype will be designed for semi-auto which required manually moving scriber along slider for x-axis and y-axis. Most of parts in this prototype are using material that anti-corrosion like aluminum and Perspex because of sacrificial coatings contain certain element which oxidize to make sure it prevent from corrosion because corrosion is one of major problems that can make die highly susceptible.

1.5 THESIS OUTLINE

The outline for the dissertation proposal and the dissertation are essentially identical for the first two chapters. The following outline is

Chapter 1: Introduction

- Overview of structure of project
- Aims/goals of project
- Problem statement
- Scope of project

Chapter 2: Literature Review

- Introduction
- Fabrication of silicon wafer and semiconductor
- Silicon wafer orientation
- Cleaving
- Wafer dicing

Chapter 3: Methodology

- Conceptual design
- Sub-functions
- Full assembly process

Chapter 4: Result and Discussion

Chapter 5: Conclusion and Future work

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Semiconducting material made from silica also known as Silicon (Si) is the fundamental building block of modern integrated circuit, diodes, rectifiers and solar cell. Jöns Jacob Berzelius, a Swedish chemist, in 1824 discovers Silicon. Although almost 130 years Silicon was discovered, it is still be used in major industrial. In, 1940's Germanium (Ge) was discover to replace Si as material in semiconductor but in 1950's Si is found more efficient semiconductor material than Ge [16]. This is because Si can raise the power output and at the same time lowering operating temperature. First appearances Si in transistor industry in 1965 is when Texas Instruments produce the first commercial silicon transistor [16]. Silicon becomes responsible for enabling the miniaturization of electronics. Today, silicon is still be used using in most transistors, integrated circuits, memory chips and even solar cell. Silicon is commercially processed by the reaction of high-purity silica in electrically heated.

Nowadays, when talks about size of silicon wafers, standard size uses in industry is 300mm which is 12 Inch in diameter. The latest size of semiconductor is 300 mm wafers are used for logic/memory and for analog device. But, there are huge semiconductor company are currently working on development of industry's next generation of wafers which increase size of wafer to 18-inch diameter. This is because overall cost benefits resulting from the larger number of dice per wafer by using same number of process steps. For example, 300 mm (12 inch) wafers will accommodate roughly twice as many dice per wafer as 200 mm wafers [1]. Based on historical trends, peak demand for 200 mm wafers will be reached around 2003, as shown in Figure 2-1. In addition, this study indicates that each wafer size remains in production for approximately 24 years allowing companies sufficient time to recoup investments in the technology. 450 mm is next targeted step in semiconductor industry, the pressure for manufacturers to maintain low costs coupled with high cost of implementing new technology as lithography costs will also increase as wafer size increase [17].

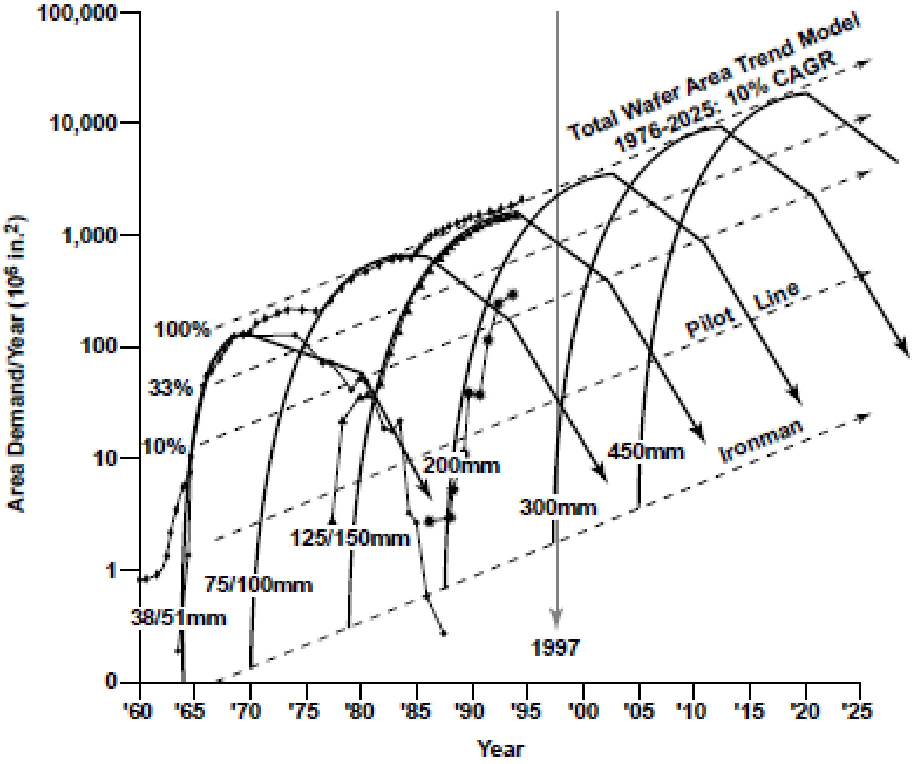

Figure 2-.1: Lifecycles of Different Wafer Sizes. [17]

2.2 FABRICATION OF SILICON WAFER AND SEMICONDUCTOR

Before using silicon, once it is extracted from sand it need to purified first. Then, heat it until melt into high-purity liquid before solidifies into silicon rod or be known as ingot. This method is known as Czochralski (CZ) process or Floating Zone Process. Czochralski's technique is invented since 100 years ago and it is worldwide method [2]. After Second World War, CZ method is use for single crystal growth. In this process, small piece of solid silicon (seed) is place in bath of molten silicon, or polycrystalline silicon and slowly pulled in rotation. Crystalline silicon growth with CZ method contain high concentration of oxygen which increase the mechanical strength of silicon leading to increased resistance to plastic deformation ,particularly important property during high temperature processing [3]. Gas fusion analysis (GFA) and secondary ion mass spectroscopy (SIMS) method is used to determine interstitial oxygen. Next, liquid will be grown into cylindrical ingot. Because of ingot size, finished wafer are in round shape. CZ method is preferred for high volume production of silicon single crystal.

After wafer has been fabricated, it will undergo into semiconductor fabrication process. Lithography is first important step in semiconductor process. In this step, pattern is transferred from photo mask to surface of wafer. Pattern then will be recorded on a layer of photoresist which developed by wet or dry etching. Its properties can be changed due to exposure to several of light or illumination. Etching is used to remove material to create specific pattern. Etchings have two types which are dry etching and wet etching. Different between this two is, wet etching is using chemical while dry etching can be done by hand [4]. Lastly is deposition. There are two methods which are physical vapor deposition process and chemical vapor deposition. Physical vapor deposition is application in the deposition of hard coatings [5]. Meanwhile for chemical vapor deposition it's application of hot filament for growth of high-quality single-crystalline cubic silicon carbide on silicon substrate [6].

2.3 SILICON WAFER ORIENTATION

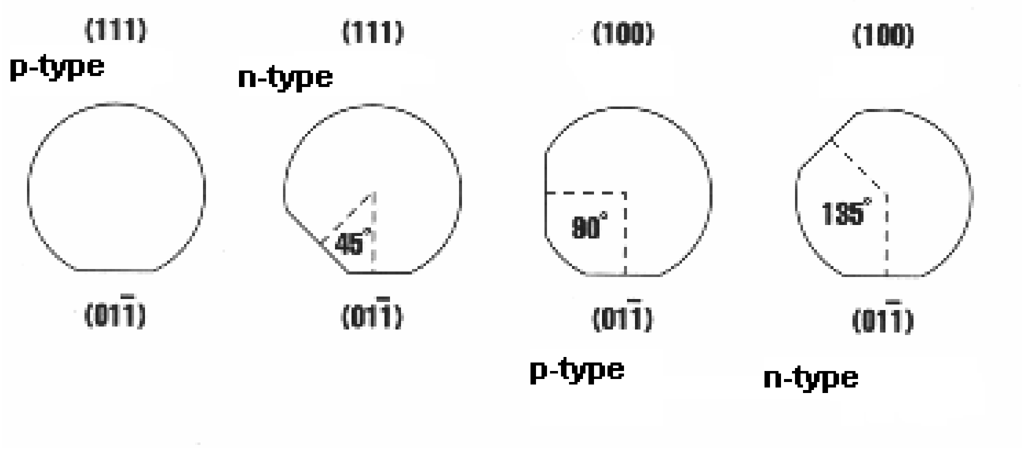

Figure 2-2: Standard flat orientation for different semiconductor wafers [7]

There are many specifications that differentiate the silicon wafers and type of electronic components they serve. Silicon wafer can be modified to change according to required functionality which involves different steps during manufacturing. One of attributes in this step is orientation of silicon. Wafers are grown on crystals that have a regular crystal structures [15]. Orientation is known as line/direction when Si wafers are slice from crystal as shown in figure 2-2. Usually, Si <100> or Si <111> wafers are most use. This number <100> and <111> are indicated as orientation of the plane parallel to the surface as shown in Figure 2-3. Different growth planes and orientations have different arrangements of the atoms or lattice as viewed from a particular angle. The <100> orientation exhibit a significantly higher exaction energy than <110>. Meanwhile, <110> orientation has lowest total energy but highest sensitivity to surface modification. [7]. The <110> orientation displays a direct transition, the <111> oriented possess a competitive indirect-direct gap character, and the <112> oriented has indirect band-gap. A lot of factor may effect growth orientation which include surface chemical treatment of substrate, nanowire diameter, composition of the initial alloy droplet, growth temperature, reaction pressure and precursor molar ratios [7]. Wafer flats are introduced to identify the orientation of the wafer surface and doping type. Since both are binary numbers that has only two possible orientations and two possible doping, one needs two logic symbols to identify the possible combinations. 90° angle between flats indicates it is a p type <100> silicon wafer while 180° angle between flats indicates it is a n type <100> silicon wafer. Absence of secondary flat indicates it is a p type <111> silicon wafer while 45° angle between flats indicates it is a n type <111> silicon wafer. There are two type of orientation which is primary and secondary flats. Primary flat is the flat of longest length located in the circumference of the wafer and is had specific crystal orientation relative to the wafer surface; major flat. Meanwhile, secondary flat indicates the crystal orientation and doping of the wafer[8].

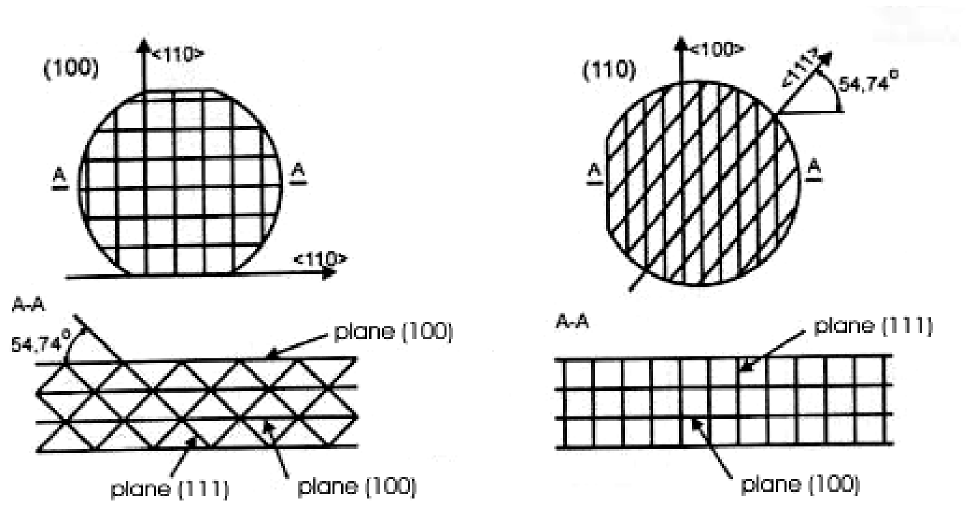

Figure 2-3: Planes configuration for (100) and (110) wafers [7]

2.4 CLEAVING

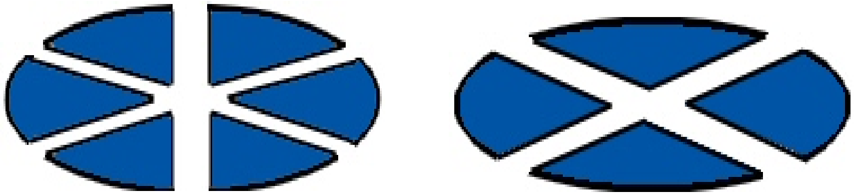

Figure 2-4: Cleaving based in crystal orientation [9]

As shown in Figure 2-4, Cleaving will run according to the crystal orientations. For example, if the crystal orientation of the Si <100> cleave at 90° while Si <111> cleave at 60°angle. Cleaving can be done by thermal stress. Thermal stress cleaving is a process used for separating a brittle material by irradiating laser beam onto a small area of substrate [9]. By using laser energy, it creates a compressive stress at the laser spot area and tensile stress around it. By introducing flaw, the crack is started from the groove tip, and the fracture can be controlled. The material separation process is like crack extension. Design device attach to silicon wafer by thin anchor [10]. When apply vertical force, it can cause fracture anchor. While, if anodically bonded, same geometrical distribution to previous design exits and causing of mechanical failure expansion. In this design, they consider highest mechanical stress which localized in same area of both materials. Manual cleaving consists of two anchors to attach each silicon ship to the wafer and one anchor to attach the glass chip. Glass anchors are located at center of chip.

2.5 WAFER DICING

Dicing MEMS/NEMS need to consider few things; sticking, particle contamination, mechanical loads, vibration/thermal and electrical sensitivity [10]. Next, there are two type of dicing wafer into individual chip which are mechanical dicing and laser. For mechanical dicing it is most widely used because of the price. The major things need to be considered using this method is to dice fragile MEMS/NEMS are the induced stress loads on the structures due to the cooling fluid and the particulate contamination from wafer-sawing residues, mainly silicon and diamond particles. The other type of dicing is dry process which is using laser. This method dicing wafer by ablation allows cutting curvilinear shapes. Debris reduction and wafer protection are required in this method and the generated heat affects the zones around the dicing lines.

The mechanical integrity of the cut surface is determined by the surface and subsurface damage generated by the wire sawing process [11]. The phenomenon of ductile cutting occurs when the local pressure at the cutting edge of the tool reaches the pressure of phase transformation. The pressure required for phase transition of silicon is about 12GPa[8]. Elastic deformation will occur if the pressure at the cutting edge does not reach the phase transformation pressure[12]. Cutting edge radius need to be considered. This is because undeformed chip thickness must be smaller than tool cutting edge radius for ductile mode[11]. During cutting wafer process the most important need to be considered are force and load apply on machine and on wafer. This is because of silicon wafer easy to break and waste of wafer defects need to be reduced.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 CONCEPTUAL DESIGN

Before finalizing a design, good amount of research has been done. From first design until third design, many things have been considered. There are many changes happened during this research by considering many aspects for example, limitation of material and limitation of machining process. Aspect stability also been considered before finalized the design. The similarity between all design is it must have main part which is wafer base for 8 inch and 4-inch wafer size diameter, linear slider to move linear direction of x-axis and y-axis, lead screw as mechanism to move in y-axis direction as move every rotation and lastly main part is scriber.

3.1.1 Design 1

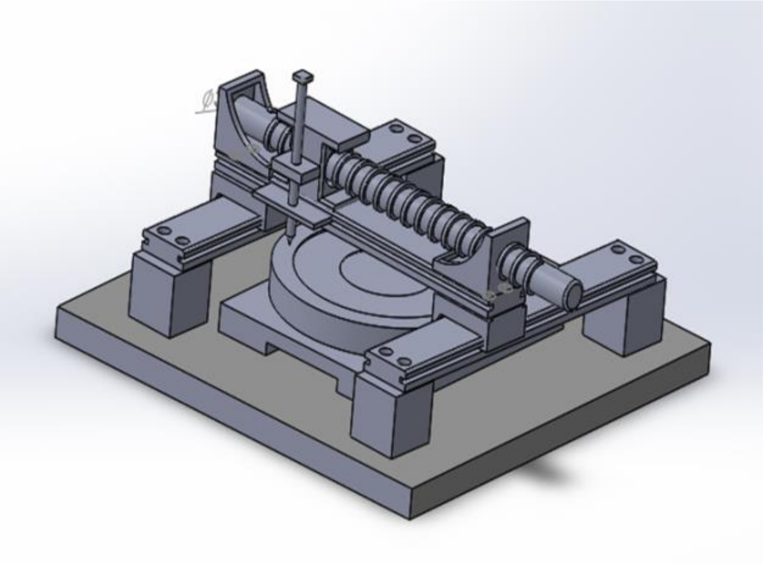

Figure 3-1: Conceptual design 1

Based on Figure 3-1, it consists all main part as listed above. Directions of movement in this design are x-axis and y-axis direction by using linear slider for two different directions. Unfortunately, by considering size of thickness wafer base, it too thick which is 40 mm. With limitation of material and machining, this thickness needs to be reduce (which does not necessary) because wafer thickness is thin. Besides that, scriber is hold in 90°angle position. Based on experience on holding pen while making long line, 90° angle position will give more disadvantage which is when moving in one line, it tend to be having vibration. This situation can give defect to result of scribing.

3.1.2 Design 2

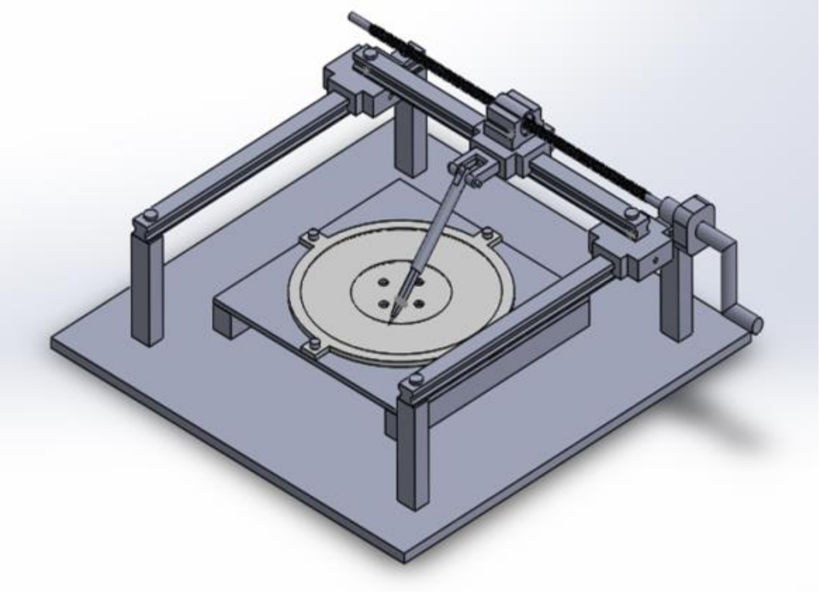

Figure 3-2: Conceptual Design 2

In Figure 3-2 shows conceptual design 2 which are different from design 1. The first changing has been done is reducing thickness of wafer base. From 40 mm thickness it had been reduced to 10 mm by considering thickness of wafer thin. In addition, based on Figure 3-1, wafer based is fixing but in design 2, wafer based can rotate manually. Wafer based have two parts which is top part and bottom part. Top part can be removed and rotated manually and be assembled again with bottom part using Allen screw. Next changing had been made is position of wafer scriber. From 90° angle position in Figure 3-1, it changes to 45° angle position which is most suitable angle. It can help to reduce or prevent vibration from happened. Unfortunately, scriber is grip at the end of scriber which can cause vibration. This design still maintains movement in x-axis and y-axis direction just like in design 1.

3.1.3 Design 3

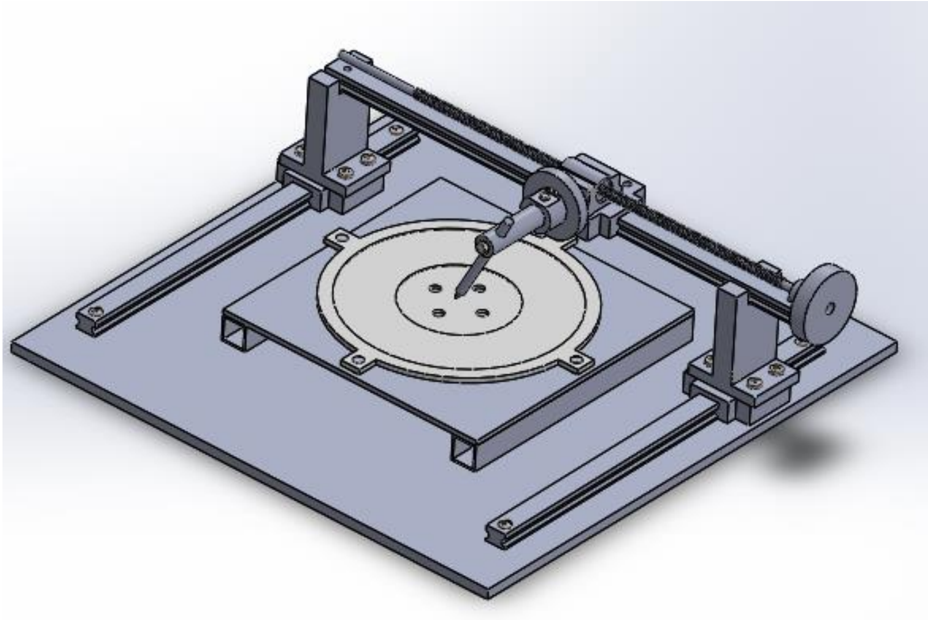

Figure 3-3: Conceptual Design 3

As shown in Figure 3-3, we can see clearly it different from design 1 and design 2 which is linear slider is located on surface of prototype base. This change happened when assembly the linear slider and support height for linear slider, problem was found. Due to weigh of linear slider also need to hold weight of y-axis linear slider and lead screw, support height cannot withstand it. It became unstable. Design of height support also has been changed. This design is more ergonomic because it is suitable for hand to hold and at the same time gives stability to support weight linear slider y-axis and lead screw. Next, scriber is being grip at the center to make sure it is tight and can prevent from vibration. Compare to design in Figure 3-2, in this design wheel handle is different because it does not have L-shape handle. This is because, lead screw does not need high force to rotate. By this design, it is more ergonomic compared to design 2. After discussing with supervisor and assistance engineer and consider some an important aspects, design 3 is finalized design for prototype of semi-auto wafer scriber for 4-inch and 8-inch wafers.

3.2 SUB-FUNCTIONS

It’s shown in Table 3-1, there is sub-function in prototype of semi-auto wafer scriber for 4-inch and 8-inch wafers. Total cost also been included in this table. This cost is real cost when purchase each part. Some parts are second hand parts due to limitation of budget.

Table 3-1: Description sub-function

Sub-function	**Description**			
	Machining	**Purchasing**	**Quantity**	**Total Cost (RM)**
Base	Yes	No	1	RM150
Linear slider	No	Yes	3	RM250 (Rm43/each)
Lead screw	NO	Yes	1	RM70
Wafer based (top and bottom)	YES	NO	2	RM80 (RM40/each)
Wafer based support height	YES	NO	2	RM20 (RM10/each)
Height Support for linear slider	YES	NO	2	RM13 (RM6.50/each)
Lead screw hand wheel	YES	NO	1	RM80
Tungsten scriber	NO	YES	1	RM13.60
Scriber Gripper	YES	NO	1	RM25
			TOTAL	**RM701.60**

3.2.1 LIST OF SUB-FUNCTIONS

Figure shown below are sub-function that included in prototype of semi-auto wafer scriber for 4 inch and 8-inch wafers and some description on dimension and material of sub-function. Machining process of these sub-functions have also been stated below.

3.2.1.1 BASE

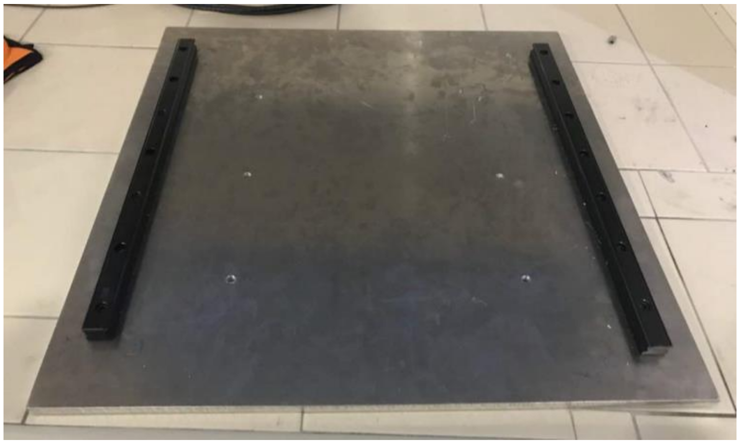

Figure 3-4: Base of prototype

As shown in Figure 3-4, base of prototype is the main sub-function. This is because this part is used for support whole part of prototype wafer scriber. Plus, it gives more stability to prototype. Dimension this part is 500 mm X 500 mm X 10 mm just shown in appendices. The material for this sub-function is aluminum. This is because of properties of aluminum is excellent resistance to corrosion. This part involved machining process like milling to make sure surface of part is flat and hole is also drilled using milling machine. This is because due to limitation of drill machine which cannot withstand big size of this part. Every hole in this part is being threaded using tap and wrench. There are 4 holes for M6 Allen screw and 6 holes for M8 Allen screw

3.2.1.2 LINEAR SLIDER

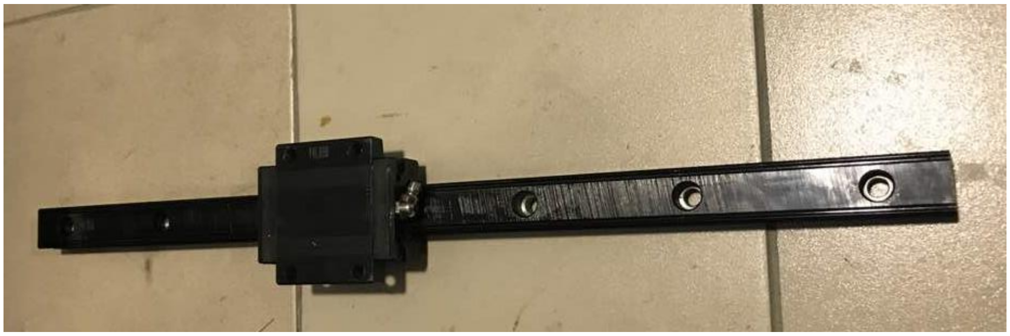

Figure 3-5: Linear slider

Based on Figure 3-5, two pieces of linear slider with size 400 mm length is use for x-axis direction while one pieces of linear slider with size 500 mm length is use for y-axis direction. This linear slider is use because it provides free and smooth motion in one direction based on bearings which is ball bearing. It also as mechanism to move along x-axis and y-axis. Main material for this sub-function is chrome steel. Chrome steel are widely used for many application s such bearings, tools and drills. Chromium in steel is lustrous, brittle and hard metal. It does not tarnish in air. There are no machining process involves in this part.

3.2.1.3 LEAD SCREW

Figure 3-6: Lead screw

As shown in figure 3-6, lead screw with dimension 500 mm is use in this prototype. Shaft diameter for this part is 20 mm diameter while lead diameter is 20 mm. It is H-Hollow shaft. Main material for this part is chrome steel. It is used to move the turret by précised increment for every rotation of the screw. It is being assembled with scriber gripper so that scriber can move along y-axis direction by rotating lead screw. There is no machining process involves in this part.

3.2.1.4 WAFER BASE

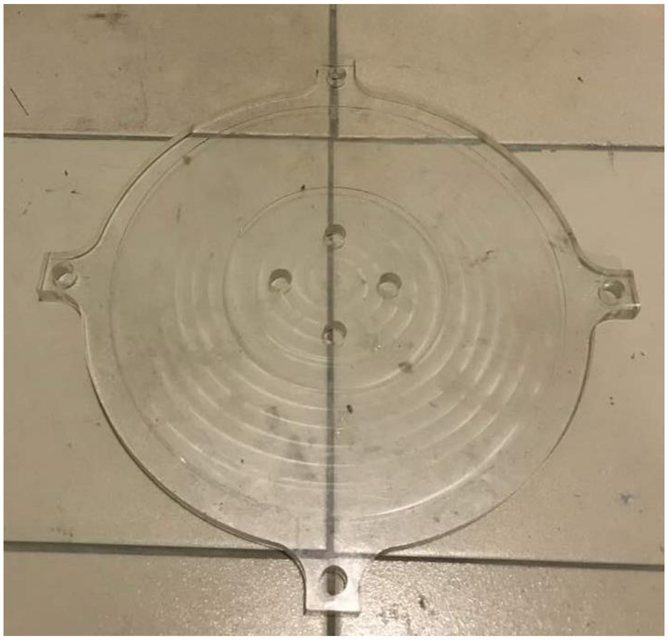

Figure 3-7: Wafer base top part

Wafer base have top part which is top and bottom part. Top part as shown in Figure 3-7 is used to place 4 inch and 8-inch wafer. It also can rotate manually by takeoff from bottom part. Basically, it size of diameter is 269.20 mm as shown in appendices. At first, top part is design from material aluminum but after consider budget and weight of aluminum, it changes to clear acrylic with thickness 10mm. machining process involves in this part is cutting by using CNC Vertical High-Speed Mill Fanuc Robodrill (Alpha T21iFb) because it ability to produce this shape as shown in Figure 3-7. While for bottom part as shown in Figure 3-8 is cut by using electric circular saw. Every hole in this part are drill with drill bits diameter 10mm.

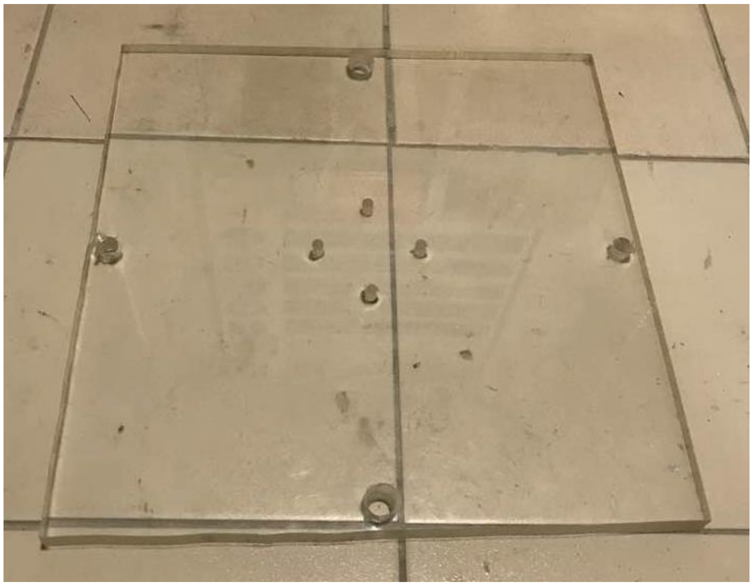

Figure 3-8: Wafer base bottom part

3.2.1.5 HEIGHT SUPPORT FOR WAFER BASED

Figure 3-9: Height support for wafer based

Just shown in figure 3-9, this part is made from aluminum hollow tube with dimension 270 mm X 20 mm X 20 mm. It is used to support height of wafer based. Machining process involved in this part is cutting and drilling process. For cutting process, Aluminum Alloy Saw Frame Hacksaw is used because of characteristic of aluminum hollow are soft so this hacksaw is chosen to compare to electric circular saw. This part will be assembly with wafer base bottom part using M8 Allen screw which required drilling process to this part. Firstly, hole need to be drill by using drill machine with 7mm diameter drill bit. To make thread along this hole, tap M8 is needed and wrenched.

3.2.1.6 HEIGHT SUPPORT FOR LINEAR SLIDER

Figure 3-10: Height support for linear slider

As shown in Figure 3-10, this part is used for to support the weight and connection between linear slider x-axis and y-axis. It also can help to move along x-axis direction. Aluminum block size 75mm X 75mm X 100mm is chose as material for this part. Basically, all process in this part is going through milling process by using vertical milling machineVM-943-3. After getting desired shape, screw hole need to be made. This process is using drill machine with drill bit size 6mm diameter because Allen screw M6 will be using this hole. To get thread in this hole, wrench and tap size M6 is chosen.

3.2.1.7 LEAD SCREW HAND WHEEL

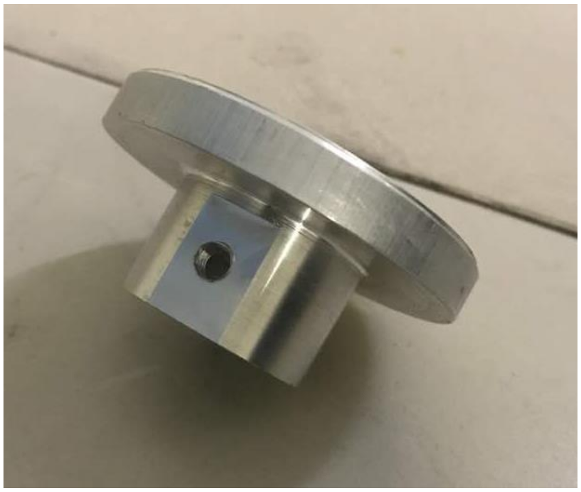

Figure 3-11: Lead screw hand wheel

Based on Figure 3-11, this simple part that can help to rotate on shaft or axle. It being assembling to lead screw so that easier to rotate. Machining process involved in this part is lathe, drilling and hand threading. This part is made from aluminum block. To get this circular and cylinder shape, lathe machine is most suitable machine to use. There are hold in the middle of this part is been drill using lathe machine by using drill bit size 8mm diameter.

3.2.1.8 TUNGSTEN SCRIBER

Figure 3-12: Tungsten scriber

As shown in Figure 3-12, tungsten scriber is chosen to make fine lines on silicon wafer because tip diameter is 1 mm. Length of this scriber is 15 mm and body diameter is 8 mm. The main material for this part is tungsten steel. Scriber features a tungsten carbide tip that marks hard materials including hardened steel, stainless steel, ceramics and glass. Knurled aluminum handle provides maximum control and comfort.

3.2.1.9 SCRIBER GRIPPER

Figure 3-13: Scriber gripper

Based on Figure 3-13, scriber gripper is used to grip scriber so that easy to scribe line on wafer surface and prevent scriber from vibration while moving x-axis direction. There are two parts in this scriber gripper which is circular shape that be attaching to lead screw head and cylinder rod to place the scriber. The machining process involved in this part is lathe process and some place need to be drilling to make hole. The lathe machine tool is used principally for shaping circle and cylinder shape and making hole at the center of cylinder. Hole is being drill for size 5mm diameter and thread is be made for M6 Allen screw by using hand threading process. In this part assemble, Allen screw M6 is be using as connection to circular part and cylinder part as shown in Figure 3-14. While for tungsten scriber, it being tighten using Allen screw M6 also so that any size diameter below than 10mm can be used as scriber for this prototype and just using Allen screw to tighten the connection.

Figure 3-14: Scriber gripper assembly by using M6 Allen screw

3.3 FULL ASSEMBLY PROCESS

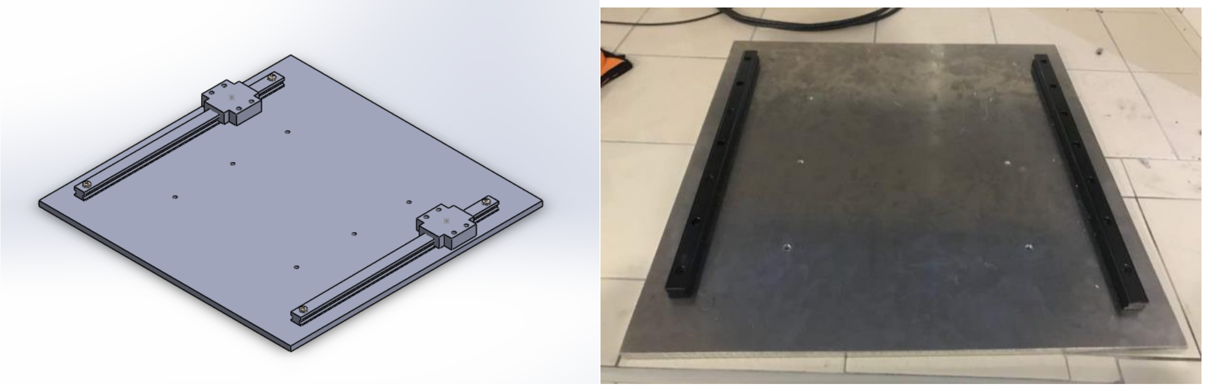

Figure 3-15: First step of assembly wafer scriber prototype

First step of assemble is need to assemble two part which is linear slider for x-axis and base of prototype. M6 Allen screw is used as connection between these two parts. But, Allen screw head need to make it smaller using lathe machine because need to make sure Allen screw head are not place above linear slider so that it can make head slider slide smoothly without any obstacle and Allen screw need to make shorter as shown in Figure 3-15.

Figure 3-146: Problem with Allen head screw

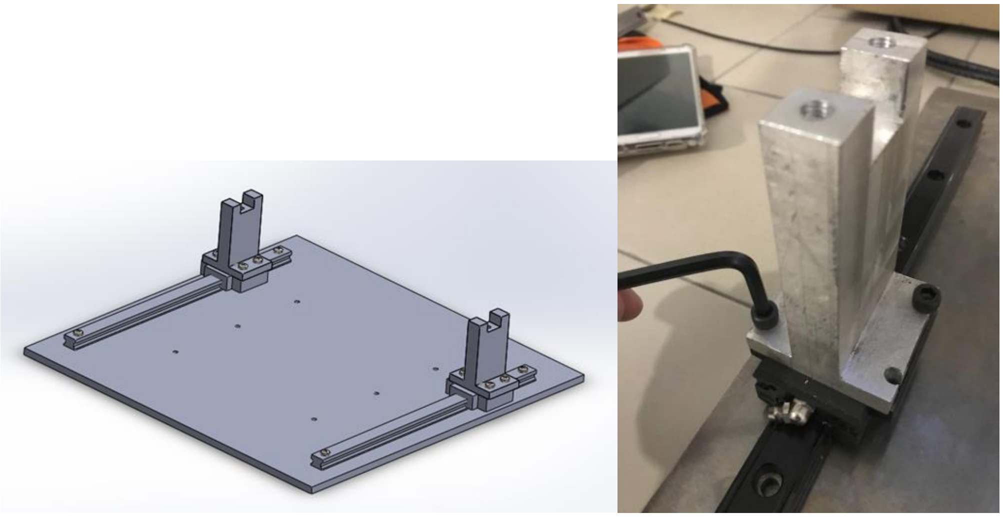

Figure 3-17: Second step of assembly wafer scriber prototype

Next step, height support is assembling to slider head like shown in Figure 3-16. This process required Allen screw M6 as connection between these two parts. Screw need to be tight so that it can prevent from having vibration.

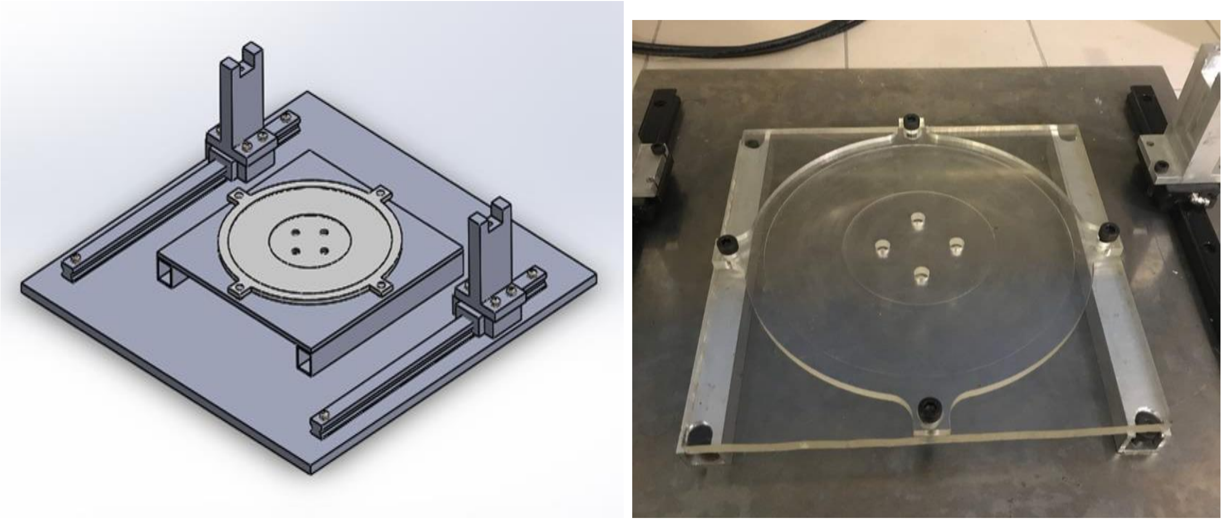

Figure 3-18: Third step of assembly wafer scriber prototype

Based on Figure 3-17 for the third step is assembly wafer based with support height of wafer based. All connection used in this part is Allen screw M8. Large diameter of screw is used in this part because this part is bigger than other parts which give good and stable connection.

Figure 3-19: Linear slider head and shaft of lead screw are assembly

Before assembly linear slider for y-axis direction, lead screw and linear screw need to assemble first as shown in Figure 3-18. This process assembly is using tap weld. This is because welding is strong connection. Unfortunately, full weld can cause bearing damaged so tap weld is the alternatives.

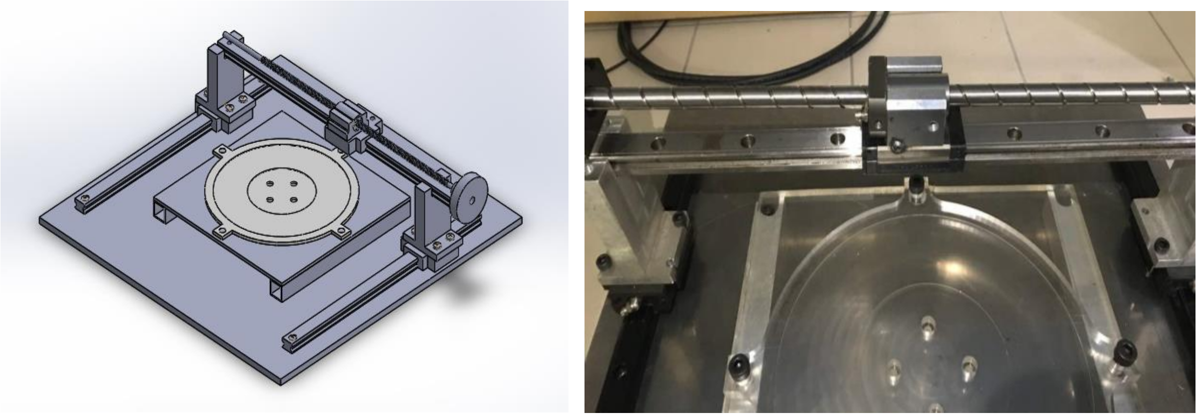

Figure 3-20: Fourth step of assembly wafer scriber prototype

Based on Figure 3-20, linear slider is place between two-part height supports. To make more stable, Allen screw M6 is used to connect linear slider and height support. This assembly process need to make sure the slider is stable when move to x-axis direction so that scriber can scribe wafer smoothly. Next, lead screw hand wheel is connecting at the end of lead screw by using Allen key M6. This screw is used to tighten the connection and at the same time when rotate wheel handle it also can rotate lead screw as shown in Figure 3-20.

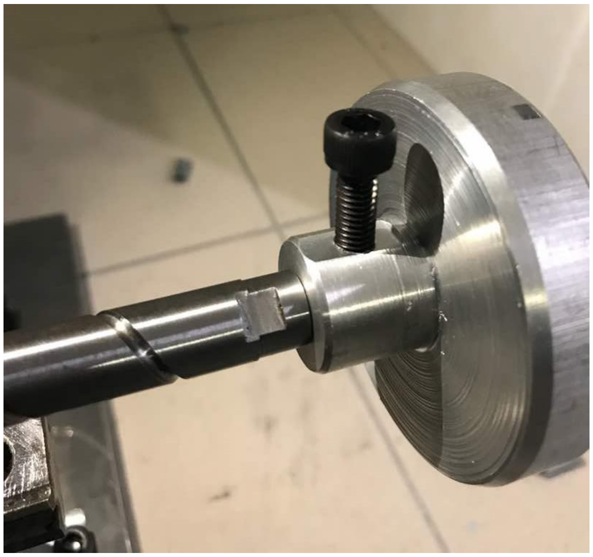

Figure 3-21: hand wheel is connecting at end lead screw