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METHOD AND APPARATUS FOR PREPARING SINGLE CRYSTAL THIN FILMS

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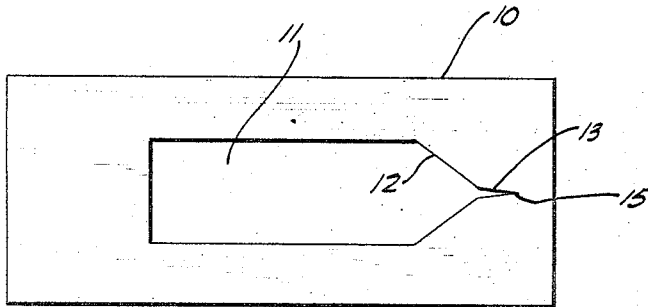


FIG. 1.

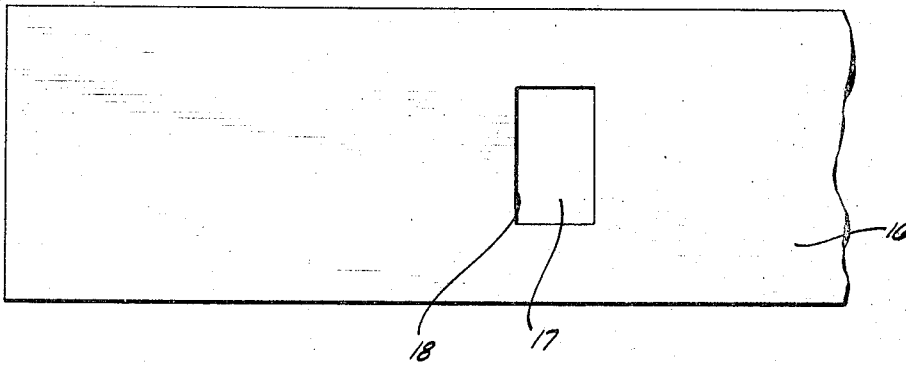


FIG. 2.

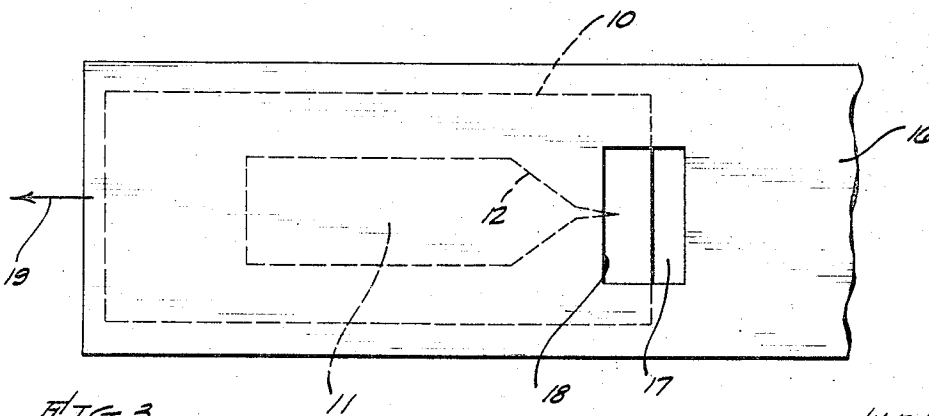


FIG. 3.

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 2 Claims. (Cl. 117-48)

This invention relates to a method and apparatus for producing single crystal thin films by evaporation-deposition methods on various types of substrates for use in microelectronics circuits or components.

In the epitaxial method of growing single crystal thin films the films or layers of controllable thickness and impurity content are grown upon single crystal substrates. Frequently it is desirable, in the manufacture of integrated circuits, transistors, diodes, etc., to deposit single crystal thin films without particular regard to the substrate or its crystalline state.

Accordingly, it is a principal object of this invention to provide a method and apparatus for the production of single crystal thin films which is not limited to the use of single crystal substrates.

Additional objects of this invention will become apparent from the following description, which is given primarily for purposes of illustration, and not limitation.

Stated in general terms, the objects of this invention are attained by depositing the single crystal thin film upon a generally chosen substrate through a fixed mask which has a narrow, tapered portion including an acute angle. A movable mask is used to gradually uncover the apex of the acute angle of the fixed mask to nucleate a crystallite at the apex of the angle and to controllably grow from the crystallite a single crystal thin film.

A more detailed description of a specific embodiment of the invention is given below with reference to the accompanying drawing, wherein:

FIG. 1 is a schematic plan view showing a fixed mask used in the method of the invention;

FIG. 2 is a similar view showing a movable mask used in the method of the invention; and

FIG. 3 is a similar view showing the movable mask placed over the fixed mask at the commencement of the crystal-growing operation.

In operation of the method, fixed mask 10, provided with an elongate opening 11, tapered at 12, narrowed at 13 by an acute angle opening and terminated at apex 15, as shown in FIG. 1, is placed upon a suitable substrate which may be amorphous, polycrystalline, or of any other suitable type. Movable mask 16, provided with a rectangular opening 17, shown in FIG. 2, is placed over fixed mask 10 in a suitable vapor deposition apparatus so that the left edge 18 of the opening is just slightly to the left of apex 14, as shown in FIG. 3.

The vapor deposition apparatus is put into operation in the usual manner practiced in the art. After a crystallite has been observed to nucleate at apex 15, movable mask 16 is slowly moved to the left in the direction of arrow 19 to slowly uncover more of narrowed portion 13 of opening 11 in fixed mask 10. As mask 16 moves further, material deposited on the crystallite increase the crystallite thickness. Material which is deposited on

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the substrate adjacent to the growing crystallite diffuses and extends the crystal growth laterally.

In this way further nucleation is inhibited and single crystal film growth is enhanced. Since there is a possibility of nucleating more than one crystal initially, the narrowed portion having a small angle section 13 enhances the probability of a single crystallite taking over control of film orientation by the time tapered portion 12 is reached. In tapered portion 12 the dimensions of the film are increased to the full width of opening 11, which is then continued for the complete length of the desired single crystal thin film.

Masks 10 and 16 are made by the use of photochemical resist masking and etching methods applied to metal foil, such as 0.0005 or 0.001 inch stainless steel shim stock foil, for example.

The rate of travel of movable mask 16 relative to fixed mask 10 is about a millimeter per hour while evaporating cadmium sulfide, for example, at about 100 A. per minute for deposition, to produce a film about 6000 A. thick.

A micrometer screw can be used to drive movable mask 16. The screw can be driven by a nylon gear which, in turn is driven by a worm gear driven by a motor outside the bell jar of the vapor deposition apparatus.

Obviously many other modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention can be practiced otherwise than as specifically described.

What is claimed is:

1. A method for preparing single crystal thin films which comprises the steps of placing a fixed mask having an elongate opening therethrough including a tapered portion with an acute angle upon a suitable substrate, placing a movable mask having an opening therethrough over the fixed mask so that only the acute angle of the opening of the fixed mask is exposed, vapor depositing crystalline material upon the acute angle-exposed portion of the substrate, and continuously moving the movable mask relative to the fixed mask to gradually expose more of the substrate while continuously vapor depositing crystalline material upon the exposed substrate and resulting deposited crystalline material.

2. Apparatus for preparing single crystal thin films which comprises a fixed mask having an elongate opening therethrough including a tapered portion with an acute angle and adapted for placement upon a suitable substrate, and a movable mask having an opening therethrough for placement over the fixed mask so that only the acute angle of the opening of the fixed mask is exposed and adapted for movement over the fixed mask to expose more of the opening therethrough.

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