Alignment

In order to make useful devices the patterns for different lithography steps that belong to a single structure must be aligned to one another. The first pattern transferred to a wafer usually includes a set of alignment marks, which are high precision features that are used as the reference when positioning subsequent patterns, to the first pattern (as shown in figure 1). Often alignment marks are included in other patterns, as the original alignment marks may be obliterated as processing progresses. It is important for each alignment mark on the wafer to be labeled so it may be identified, and for each pattern to specify the alignment mark (and the location thereof) to which it should be aligned. By providing the location of the alignment mark it is easy for the operator to locate the correct feature in a short time. Each pattern layer should have an alignment feature so that it may be registered to the rest of the layers.

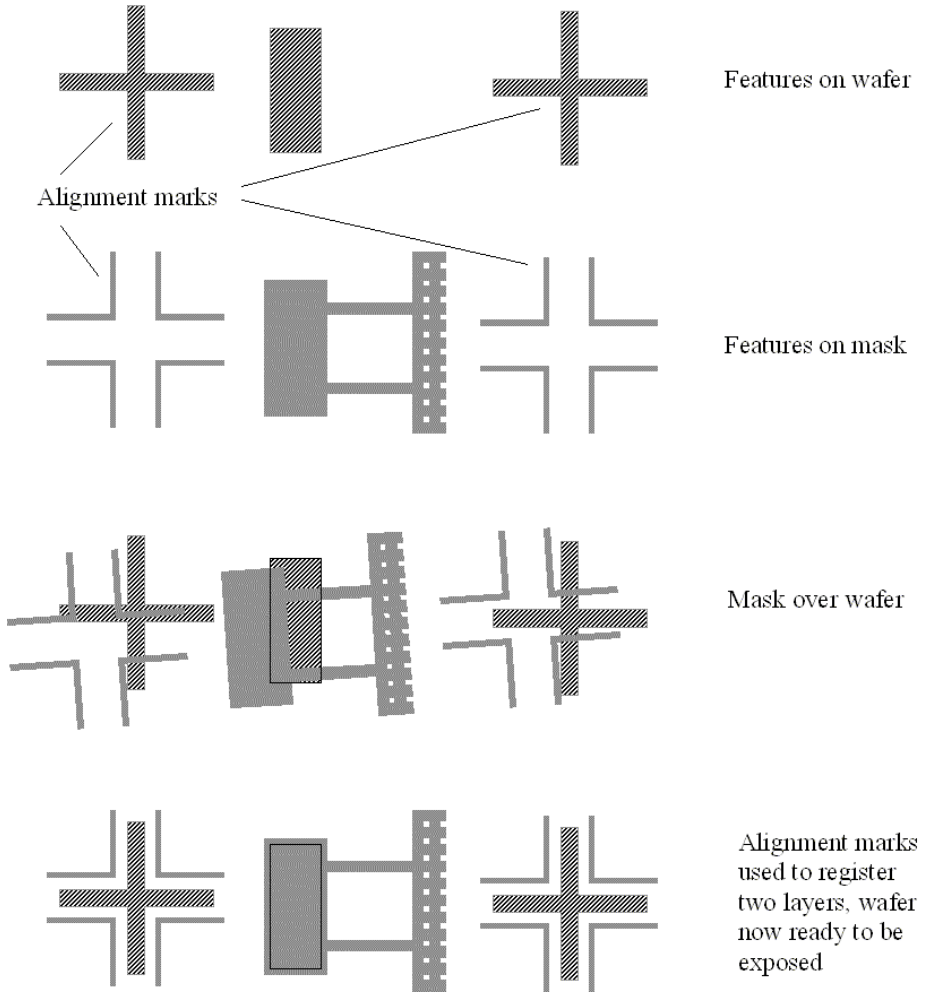

Figure 1: Use of alignment marks to register subsequent layers

Depending on the lithography equipment used, the feature on the mask used for registration of the mask may be transferred to the wafer (as shown in figure 2). In this case, it may be important to locate the alignment marks such that they don't effect subsequent wafer processing or device

performance. For example, the alignment mark shown in figure 3 will cease to exist after a through the wafer DRIE etch. Pattern transfer of the mask alignment features to the wafer may obliterate the alignment features on the wafer. In this case the alignment marks should be designed to minimize this effect, or alternately there should be multiple copies of the alignment marks on the wafer, so there will be alignment marks remaining for other masks to be registered to.

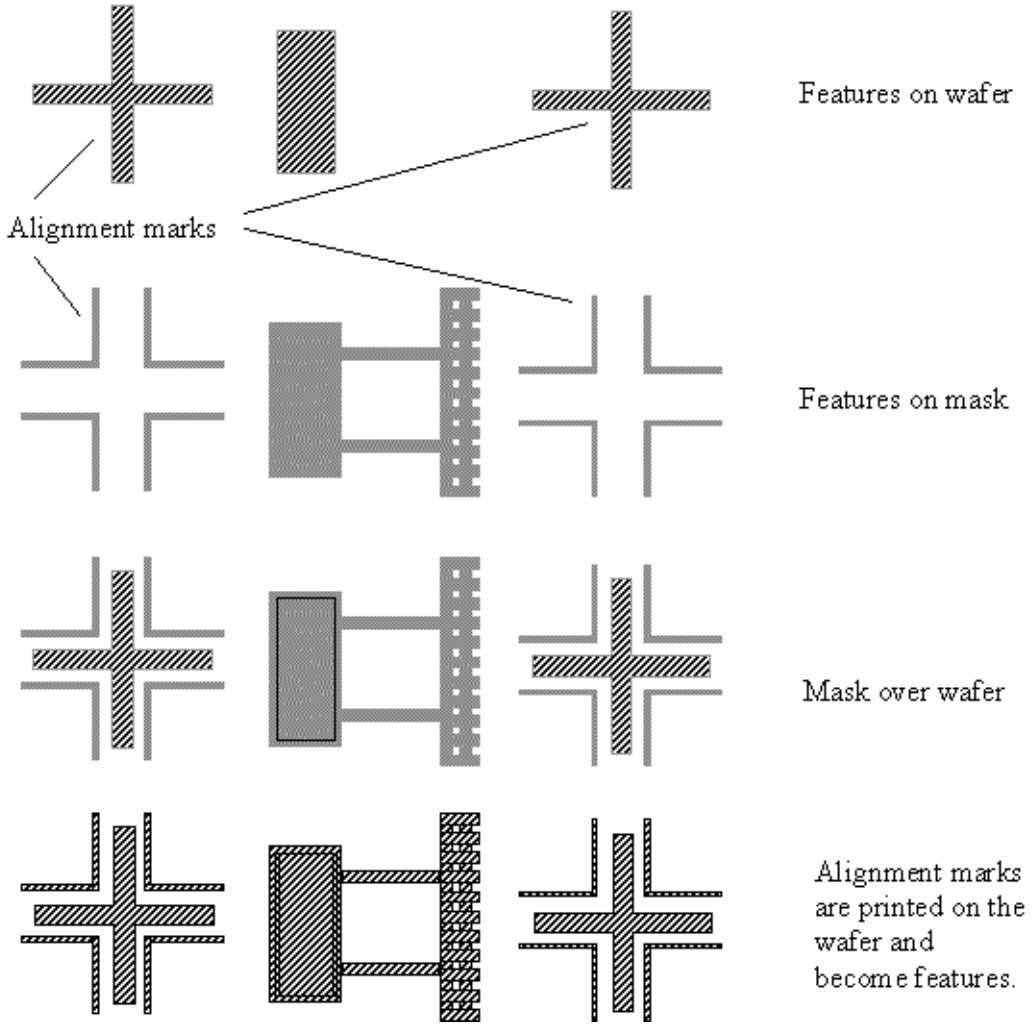

Figure 2: Transfer of mask registration feature to substrate during lithography (contact aligner*)*

Alignment marks may not necessarily be arbitrarily located on the wafer, as the equipment used to perform alignment may have limited travel and therefore only be able to align to features located within a certain region on the wafer (as shown in figure 4). The region location geometry and size may also vary with the type of alignment, so the lithographic equipment and type of alignment to be used should be considered before locating alignment marks. Typically two alignment marks are used to align the mask and wafer, one alignment mark is sufficient to align the mask and wafer in x and y, but it requires two marks (preferably spaced far apart) to correct for fine offset in rotation.

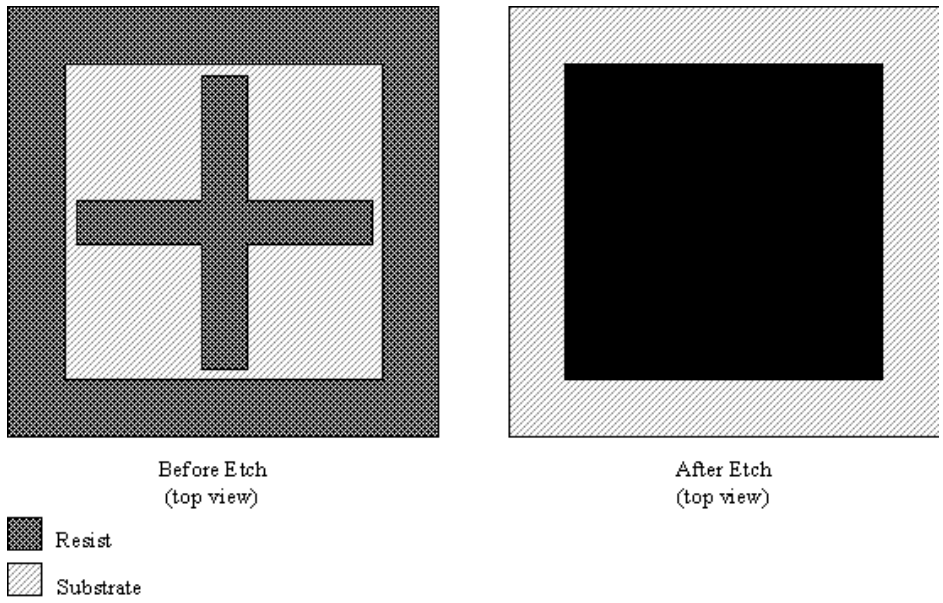

Figure 3: Poor alignment mark design for a through the wafer etch (cross hair is released and lost)

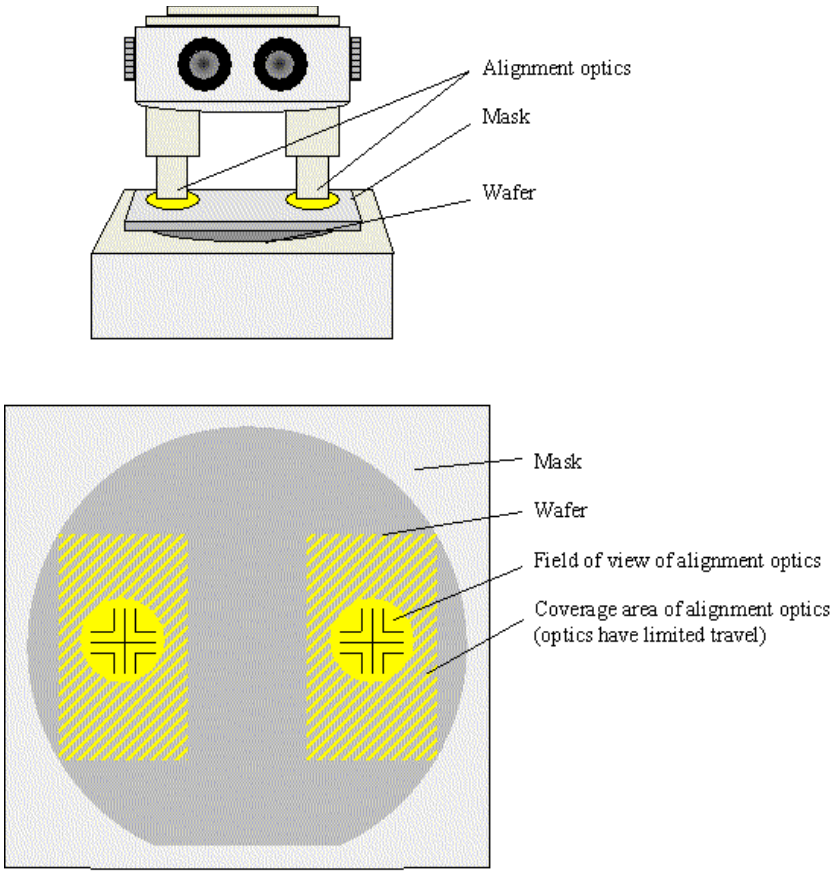

Figure 4: Restriction of location of alignment marks based on equipment used.