Appendix 5: Most Commonly Encountered Material Removal Process Steps

The most commonly encountered MEMS material removal process steps for beginning students are summarized below, together with the typical process conditions. Each of the method is commonly applied for one type of target material due to consideration of etch rate and etch selectivity. Even though a target material is identified for each etching method, it is possible to use the etching methods on other materials.

The following is a list of solution-based wet etching processes.

Process name	**Process conditions**	**Common target material**
Hydrofluoric acid wet etching	Room temperature.	Silicon dioxide
Wet EDP silicon etching	90°C solution temperature in a reflux system.	Single crystal silicon
Wet KOH silicon etching	50-100°C solution temperature.	Single crystal silicon
Acetone etch	Room temperature.	Photoresist
Photoresist developer	Room temperature.	Photoresist
Hot H_3PO_4 wet etch	180°C enclosed system.	Silicon nitride
HF vapor (high concentration)	Room temperature exposure to HF vapor	Silicon dioxide

The following is a list of dry (gas-phase or vacuum-based) etching processes.

Process name	**Process conditions**	**Target material**
Oxygen plasma etching	Room temperature. Pure oxygen plasma.	Photoresist and organic polymers
Plasma etching with SF_6	Room temperature.	Silicon or polysilicon
Plasma etching with CF_4	Room temperature.	Silicon nitride
Deep reactive ion etching	Deep, high aspect ratio etching of silicon with the substrate kept at room temperature.	Silicon
XeF_2 silicon gas phase etching	Room temperature.	Silicon