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science under pressure

Driller vs Gasket Drilling Service

Application Note

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Preparing for a high pressure experiment with a diamond anvil cell (DAC) requires several steps to follow before actually loading the sample inside the DAC. We present here the possible options provided by Almax easyLab in order to prepare the sample chamber.

The DAC consists of two anvils which are squeezing a drilled gasket. The sample which is contained inside the hole of the drilled gasket is then subjected to high pressure. Before loading a sample into the DAC, one has to align well the two anvils and then prepare the sample chamber. This is done in two steps: the gasket pre-indentation and the gasket drilling.

The gasket pre-indentation is essential to limit its plastic deformation when applying high load during the experiment. If the gasket is not pre-indented to the right thickness then it will deform when increasing pressure which can induce sample loss and a high risk of damaging the anvils. A general rule is to pre-indent the gasket to a thickness between 10% and 20% of the culet size.

The gasket drilling is very important since it will “shape” the sample chamber. A perfect quality hole will increase the chance to reach higher pressures. In most of the DAC experiments, the gasket is made of metal. For that reason it is convenient to use an electric discharge machine to drill the hole. Almax easyLab provides the Boehler microdriller (spark eroder) allowing the users to drill a wide range of sizes (from 0.05 to 1 mm diameter). Ideally, the hole diameter should be between 33% and 50% of the culet size. This hole must be concentric to the culets (hole well centred on both sides of the DAC). After the high pressure run, the gasket has been thinned down so it cannot be reused.

If a user doesn't have access to a driller, Almax easyLab also provides a gasket drilling service. It is thus possible to order “ready to go” gaskets, bearing in mind that there are several situations which leads to different results in terms of gasket quality. Figure 1 summarizes the different possible cases in a flowchart.

CASE 1: New DAC order.

The gaskets can be prepared by Almax easyLab if gasket pre-indentation and drilling is also ordered (conditions: 20 gaskets maximum and C >0.2 mm). If the customer has also ordered a Boehler microdriller, the gaskets can be prepared in house by the customer.

CASE 2: Existing DAC. Pre-indentation of the gaskets at customer’s lab. Drilling at Almax easyLab.

This is not ideal because there is a risk that the hole is not well centred on both sides after drilling because of anvil misalignment during pre- indentation. In this case, it is crucial to check the anvil alignment after each gasket pre- indentation in order to make sure both anvils are well aligned.

CASE 3: Existing DAC. Pre-indentation and drilling at Almax easyLab without the DAC.

This case is the less convenient since the pre-indentation is not done with the anvils used in the actual DAC. Almax easyLab can pre-indent gaskets using anvils with the same size but it is depending on stock availability. If no anvils are available, the gasket indenter is used but the carbide dies have a rounded shape and about 0.05 mm undersized culet. That means that it will not be perfectly matching the anvils which are fitted inside the DAC (less stability during the high pressure run).

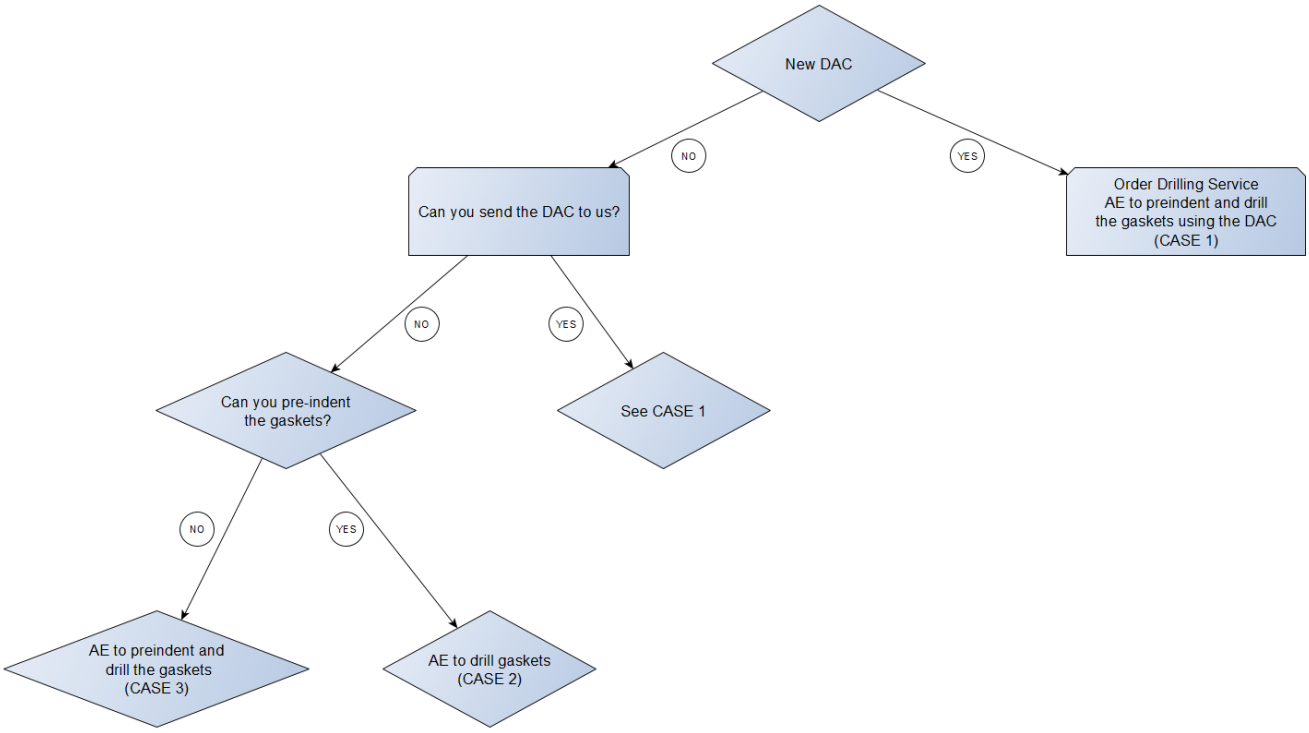

Figure 1: Flowchart of the possible situations encountered and the solutions proposed by Almax easyLab for the gasket drilling.

In summary, there are 3 different possibilities (see details above). The best quality gasket is obtained in case 1. In the other two cases, the statistics to obtain high quality gasket are lower since all conditions needed to prepare the gasket are not met. Ideally, scientists using a DAC should prepare their own gaskets to increase the chance to reach the results expected in their specific experiments. The results will improve with time and experience. For that reason, Almax easyLab also provides DAC training for users which have not yet the experience with DACs and high pressure experiments.