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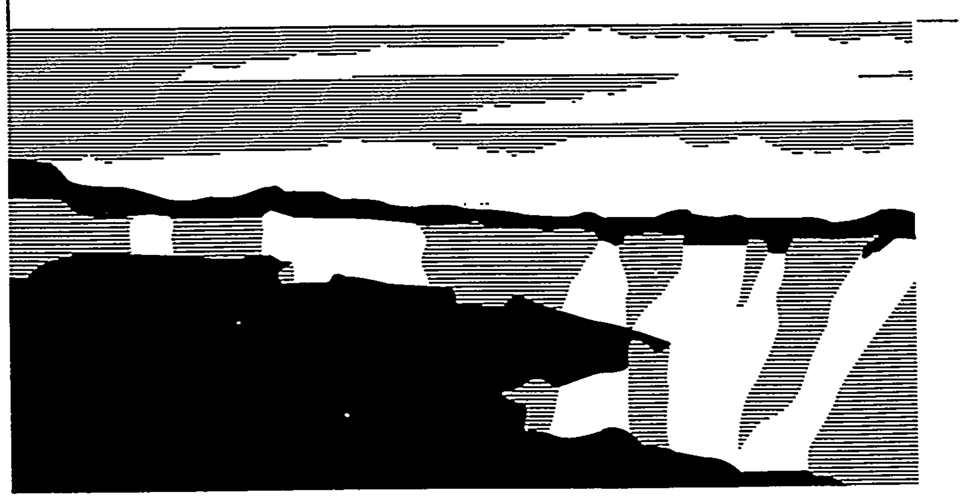

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Fabrication Process of Machined and Shrink Fitted Impactor; Composite Liners for the Los Alamos HEDP Program

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Abstract

Composite liners have been fabricated for the Los Alamos liner driven HEDP experiments using impactors formed by physical vapor deposition (PVD), electroplating, machining and shrink fitting. Chemical vapor deposition (CVD) has been proposed for some ATLAS liner applications. This paper describes the processes used to fabricate machined and shrink fitted impactors which have been used for copper impactors in 1100 aluminum liners and 6061 T-6 aluminum impactors in 1100 aluminum liners. The most successful processes have been largely empirically developed and rely upon a combination of shrink fitted and light press fitting. The processes used to date will be described along with some considerations for future composite liner requirements in the HEDP Program.

Introduction

Fabrication processes for machined and shrink fitted impactor style liners have been developed for the HEDP Program at Los Alamos utilizing numerically controlled CNC machining capabilities. At present we have fabricated 5 impactor style liners, RT&E Mix 1 &2 with copper impactors, and High Strain Rate 1,2 &3 with 6061 T-6 aluminum impactors. The liners were machined on a Hardinge Super-Precision CNC Chucker lathe. This lathe has a precision bearing spindle that is capable of producing finishes down to 4 micro-inch rms (Rq). This machine uses a multi-tool removable turret system with repeatability to within 20 millionths (.00002) of an inch. The machine that we have acquired at Los Alamos has a 5C-threaded nose spindle that receives hardened precision ground collets or machinable soft collets for specialized type workpieces. Adaptable faceplates mount on the threaded nose spindle and allow for specialized workpieces to be mounted. Faceplate fixtures can be removed and replaced on the spindle without loosing parallelism and concentricity between features, very important to the process described in this paper.

Liner Fabrication Process (roughing stages)

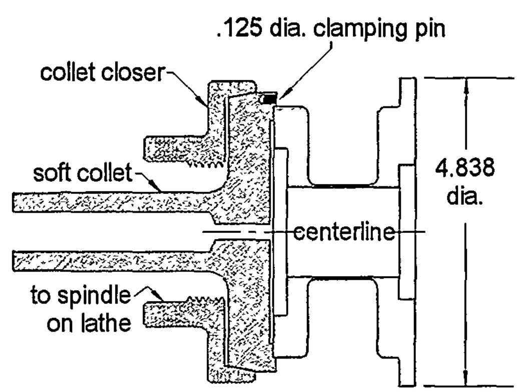
Liner fabrication on the Hardinge Chucker is done in three stages. The first two stages are roughing stages, and the third stage is a finishing stage. At the first stage the liner is rough machined to within 10 thousandths (.010") of an inch on all dimensions except the cylinder wall portion. This is left heavy for strength during drilling operations. After the first stage has been completed drilling operations are performed on a CNC mill. Second stage operations are then performed and all dimensions are machined to within 3 thousandths (.003") of an inch except the current joint on the small flange end which is finish machined. The .003" of material left on the liner allows for finish machining at the third stage with (PCD) Polycrystalline Diamond cutting tools, providing 5-10 micro-inch rms surface finishes when specified.

A machinable soft collet and closer system from Hardinge is used to hold workpieces on the first two stages. A roughing turret is used on the first two stages for holding special hand made high-speed grooving tools, used for heavy roughing operations and chip control. Ceramic-coated (KC-730) inserts from Kennametal are used on the first two stages for finish machining operations.

Impactor Sleeve Fabrication Process

Impactor sleeves are made into a cylindrical tube that has a flange on one end. The outside diameter is left oversize and the inside diameter is made undersize, leaving material for finish machining. The sleeve is put onto a brass mandrel and the outside diameter is finish machined using a (PCD) diamond insert to a 6 micro-inch surface finish. This allows for smooth insertion into liner mating bore. The outside diameter is finish machined to a tolerance of 20 to 40 millionths (.00002" to .00004") less than the mating bore of the liner. At the flange end of the impactor sleeve the last 100 thousandths (.100") of cylinder height is made 2 tenths (.0002") larger in diameter. This allows for a light press fit at the small flange end of liner when the sleeve is inserted.

Preparation of Liner to Receive Impactor Sleeve

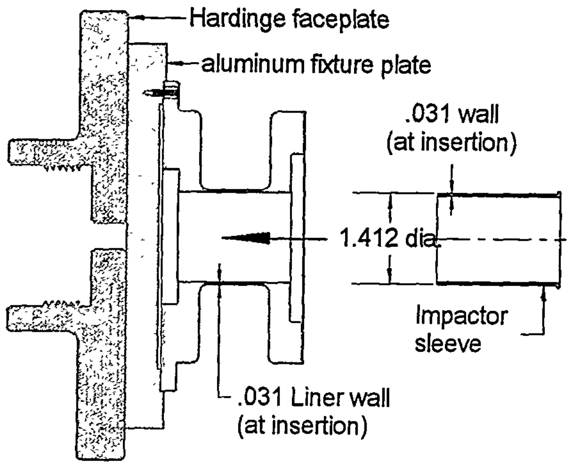


soft collet holding High Strain Rate Liner

At this point the liner small flange end is held in a specially made soft collet. The collet pocket is bored 5 tenths (.0005") smaller in diameter than the small flange of the liner. Three (3) clamping pins are left in the soft collet so that very little clamping pressure is put onto the liner flange when being clamped, this prevents the liner from distorting. The face, outside diameter, and the counterbore of the large flange end is then finished to specification. The liner's finished large flange end is then placed on a Hardinge faceplate with an aluminum fixture plate permanently attached to the faceplate. The liner is attached to the aluminum fixture plate by using four (4) existing holes that are already in the liner. This faceplate fixture can be removed and reinstalled at any time without loosing concentricity of liner features.

The 1100 aluminum liner bore is then finish machined to a 6 micro-inch surface finish for smooth insertion of the impactor sleeve. The last 100 thousandths (.100") of liner bore is finished 2 tenths (.0002") smaller in diameter. This provides a light press fit at the large end of liner at impactor sleeve insertion.

Impactor Sleeve Insertion into liner



<u>**Impactor insertion (High Strain Rate Liner)**</u>

The faceplate fixture with liner attached is removed from the threaded nose spindle and the liner bore is cleaned with ethanol and then allowed to thermally equilibrate at room temperature. The impactor sleeve is also cleaned with ethanol and then cooled by rapid evaporation of ethanol, stimulated by a clean, dry, compressed air shower. Thermal contraction slightly reduces the diameter of the impactor. After cleaning and cooling the impactor sleeve, it is very carefully inserted into the liner mating bore. The two mating parts are designed to provide a light press fit at both ends of the impactor sleeve at thermal equilibrium but are not intentionally strained over the active length of the composite liner. The press fit at the impactor ends is believed to insure coupling of spindle torque to the impactor sleeve while the inside diameter is being finished.

Finish Composite Liner to Completion (third stage)

The faceplate fixture with the now composite liner attached is put back on the threaded nose spindle of the Hardinge Chucker lathe. A finishing turret is placed onto the lathe and all outside and inside contours can then be finished with (PCD) diamond tooling. This includes the inside diameter of the 6061 T-6 aluminum impactor that has already been inserted. This method of fixturing allows all critical dimensions to be machined in the same setup, thereby preventing loss of parallelism or concentricity between features. All CNC programs, tool settings, soft collets, and fixturing are saved and can be used for future liner fabrication.

Conclusion

Composite liners have been fabricated for Pegasus with machined metal impactors as thin as .008" (200 um) wall thickness. Machining and fabrication methods are described here that insure concentricity between the liner and impactor, that do not physically distort the composite liner, yet provide sufficient interfacial force to allow finish machining operations on the impactor and provide physical stability of the composite for liner driven experiments. We expect to be able to extent the fabrication method to even thinner impactors, perhaps less than .004" (100 um) thick, and to use additional materials for impactors. Composite liners have also been fabricated for Pegasus based upon coating technologies including electroplated gold and physical vapor deposited platinum. Chemical vapor deposited tungsten is being evaluated for composite liners proposed for the Atlas facility under construction at Los Alamos.

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