EXPERIMENTALLY PRODUCED HYPERVELOCITY IMPACT CRATERS IN GOLD: SOME PRELIMINARY RESULTS; M.R. Laurance, Department of Astronomy, University of Washington, Seattle, WA 98195

Many different materials have been tested through projectile-target experiments to determine their suitability for capturing micrometeoroids. Previously, one projectile would be shot at a single target during an experiment. Due to the changing conditions of the gun apparatus from shot to shot, the same projectile velocity cannot be reproduced from experiment to experiment. A new technique for producing multiple impacts per shot experiment has been developed and successfully employed.[1] The advantage to this technique is that multiple targets can be simultaneously tested and compared with each other under the same initial conditions.

Here we report results from one such experiment. Three target materials were used in this experiment: gold, aerogel and TPX microporous foam. The projectile material itself was made up of discrete particles sorted into the $100\,\mu m$ to $150\,\mu m$ size range. The content was 75% glass spheres, 12.5% Twin Sisters olivine and 12.5% iron sulfide. This analysis concerns the impacts produced in the gold disk.

This experiment was performed at the NASA/Ames Research Center Vertical Gun Range using a Two-Stage Light Gas Gun. The initial velocity of the projectiles was $5.13 km\ s^{-1}$. These particles produced hypervelocity impact craters in the gold disk. The disk was scanned optically with a stereo optical microscope and scanned in the scanning electron microscope (SEM). Craters were found that range in size from $< 1\,\mu m$ to $450\,\mu m$ in diameter (D). All craters exhibit the classic characteristics of hypervelocity impacts into metals such as bowl shaped interiors and raised, petalled rims.[2] This analysis surveys the 36 craters found with $D \geq 40\,\mu m$. All craters appear to have abundant projectile residue in their interiors which is easily detectable in the SEM with a standard solid-state (Si-Li) X-ray detector. Elements lighter than Na which would be present in the olivine and glass would not be detectable with our X-ray system. Each projectile type has a distinct chemical signature which makes identification of the impactor very easy. Fifty three percent of the craters are made by glass impactors, 31% by olivine and 17% by iron sulfide. The glass spheres are composed of Na, Mg, Si and Ca, the olivine particles Mg, Si and Fe and the iron sulfide particles are FeS. Since the chemical signature of the residues of the different craters very closely match their parent projectile types, it appears that at this velocity we are seeing little if any volatilization of the lighter elements taking place.

The morphology of the crater residue ranges from smooth iron sulfide and glass melts to vesicular glass melts to partially melted chunks of olivine. The appearance of the melt and target material in the glass craters is very similar to what Hörz *et al.*[3] found in previous experiments using basalt glass projectiles in gold targets. They found smooth and highly vesiculated melt morphologies with burst vesicles. We see the same phenomenon in almost all of our glass craters. The glass and iron sulfide melts in our experiment appear to be intimately mixed with the gold substrate. We have seen this before in hypervelocity impact craters in the Solar Max aluminum thermal control louvers.[2] On the other hand, some of the olivine is preserved as unmixed partially melted fragments which sit on the surface of the crater interior. This is similar to what Schramm and McKay[4] found in a Solar Max thermal control louver crater.

We are observing craters that are in a much larger size range than the original projectiles. From previous experience,[2] we would expect to see craters in the $300\,\mu m$ to $450\,\mu m$ size range. Since there are craters that appear to be much smaller than the original projectile size and we also see craters within craters, the projectiles probably came down the gun barrel in a cloud with many being broken from the force of being launched. This would help to explain why we have observed mostly small ($< 100\,\mu m$) fragments of projectiles in the aerogel.[1]

The results of this experiment support previous findings that metal surfaces may be suitable for collecting information on micrometeoroids through impact cratering. Though we have already seen that mineral phase information may be preserved in the molten residues of hypervelocity impactors,[4] this experiment shows that partially melted projectile residues may be preserved in hypervelocity impacts as well. The major drawbacks to this technique are that the impactor is partially or completely destroyed in the process of being captured and much information on its original mass, size and structure is lost. The results from the examination of hypervelocity impact craters in metals such as gold and aluminum could result in a selection of materials used in the framework of future space-borne collectors so that the area the collector framework occupies could be used for meteoroid collection in addition to the collection media that are being used.

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