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# Report on coating from Teer

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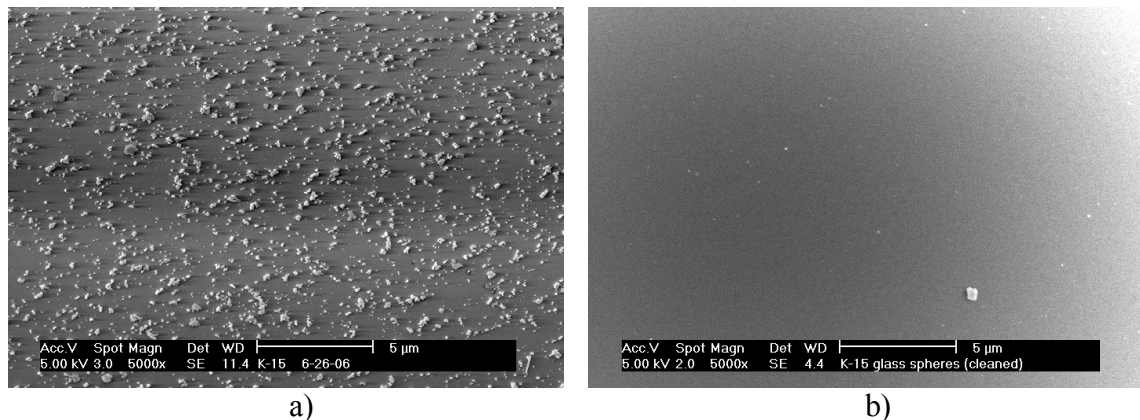
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Re: Report on coating from Teer

### Coating Parameters

A trial coating run has been performed at Teer Coating LTD to assess the use of a barrel coating system as a viable option to coat multilayer spheres. Hollow glass spheres (3M K15) ranging in diameter from 70- 120 microns were cleaned in a process using a 0.1 M HCl solution. Comparative photos before and after the cleaning process are shown in figure 1.



**Figure 1- a) surface of glass microsphere before cleaning b) surface of glass microsphere after cleaning**

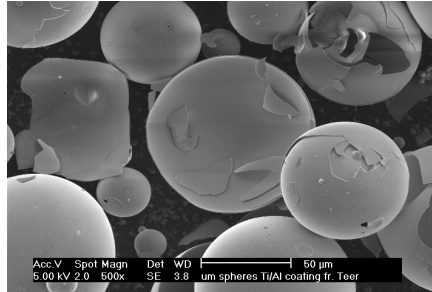
Approximately, 2 liters of cleaned spheres were sent to Teer for the trial coating in their barrel coater. A picture of barrel coating system is shown in figure 2. The coating process was one layer of titanium followed by one layer of aluminum. The target thickness for each layer is 500 nm, however, no rate runs were performed to calibrate the parameters. Each layer was sputtered for 10 hours, for a total of 20 hours.



**Figure 2- a) Picture of the barrel coating system b) Close-up picture of the barrel with some material inside (not our microspheres)**

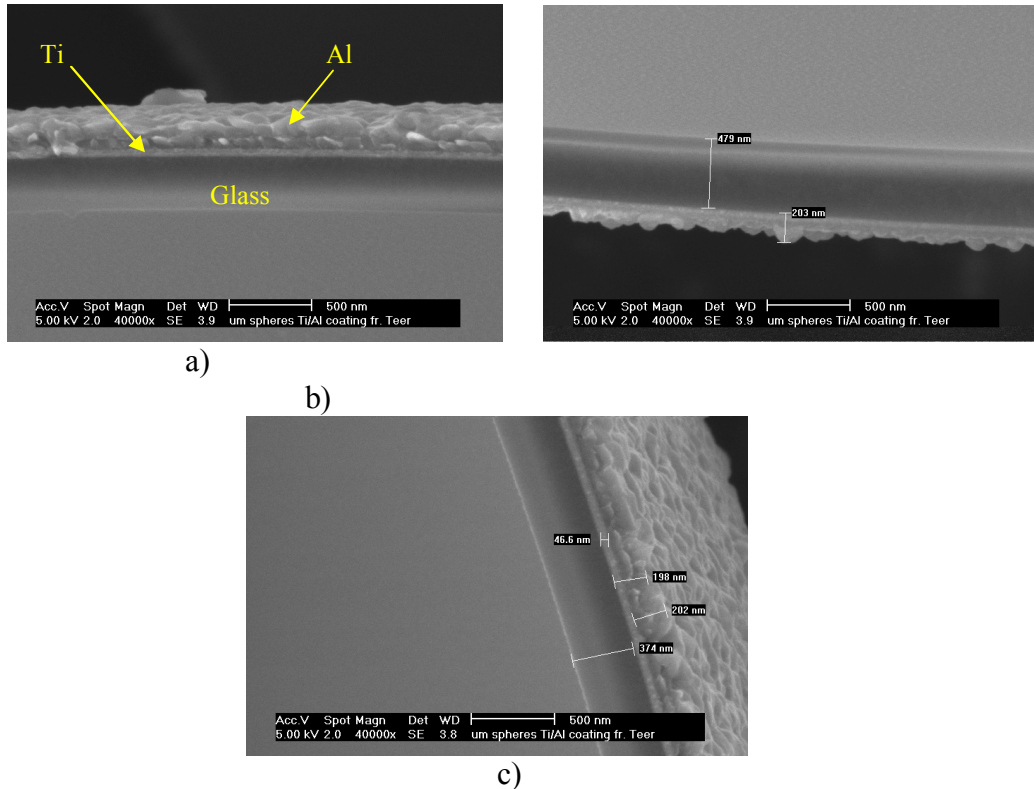
## SEM Analysis

After the coating process, the coated spheres were sent back to LLNL for SEM analysis. In order to quickly examine the coating in cross-section, the spheres were broken with a spatula. Photos of the broken spheres are shown in Fig 3. One sphere was chosen to look at the uniformity around the sphere.



**Figure 3- Overview of coated microspheres, some were broken to look at cross-section**

As can be seen in Figure 4, there is fairly good uniformity around the sphere. You can also distinguish between the Ti (lighter) and Al layers, however it appears the Al is quite a bit thicker. This result is not too surprising because in general Al deposits faster than Ti. Figure 4 also shows the surface morphology of the top Al layer. Although it is still quite rough, it appears to be smoother than the Teer coating with just Al on glass.



**Figure 4- Cross-section views showing the Ti and Al layer thicknesses at different points along the perimeter of the coated sphere a) 12 o'clock b) 6 o'clock c) 3 o'clock. The thickness appears to be fairly uniform around sphere, indicating that the balls were rolling well during the deposition process.**

**Recommendation**

Based on this analysis, we believe that the barrel coating system can produce uniform coatings and is the correct deposition configuration to coat large quantities of microspheres. However, given the variation in thickness and surface roughness of the current coatings, the process needs further development in order to produce the high quality multilayers required. Other variables including optimum material combinations, layer pair thickness, optimum surface preparation, cleaning, and coating parameters need to be optimized to fully assess this technology.