

## Summary of discussion on materials options for the NSTX divertor module

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### **Introduction**

The flowing liquid metal divertor module for NSTX under consideration by the ALIST group has the primary mission to provide particle removal and reduce recycling at the NSTX boundary. It is agreed that liquid lithium is well suited to this task and is the preferred option for the module design. However other materials are under consideration as alternates to lithium.

Broadly, the material options can be classified as 1) liquid metals and alloys, 2) molten liquid salts, and 3) polymeric liquids. The last two classes of materials are interesting because of their low electrical conductivity and consequent mitigation of the magnetic drag/deflection problem associated with conducting liquids. However, in the case of polymeric liquids we have rather low thermal conductivity which prevents application in NSTX. In the case of molten salts we have the options of FLIBE and FLINABE. These are better thermal conductors, but the presence of beryllium in the materials prevents their use because of unusual ES&H cost burden. This leaves us to consider liquid metals and their alloys.

Several liquid metals and alloys have been proposed for ALPS applications and at this time we can provide a simple comparison among them for possible use in NSTX. The results of the group discussion at the PPPL meeting are summarized in table 1.

**Table 1 Back up material options for NSTX**

	Pumping	Pro issues	Con-issues
Gallium	New data from PISCES indicates ~500ppm H retention.  For NSTX case this is within a factor of x 2 of the design pumping target	Excellent thermal properties and heat removal  Low fire hazard Low vapor pressure	Mobilization of sub mm droplets  Maybe difficult to clean up  Corrosion to solid metals and pipes at high temperature.
Tin	Theory says bubble formation will lead to good pumping. No data yet	Low fire hazard Low vapor pressure.	Difficult to clean spills in vacuum vessel.  Corrosive to solid metals and pipes
Tin/Lithium	Should pump similar to Li, but no data yet. Note phase segregation of lithium to the surface.		Complex phase diagram. Melting experiments lead to clumping. Thermal conductivity data uncertain. Fire hazard unknown.
Lithium/Gallium (similar to pure Ga)	May pump better than gallium no data yet.		Phase diagram and other properties not well known. Should be similar to tin/lithium diagram. Fire hazard unknown.

Several questions and observations arose during the discussion in addition to those indicated above.

General question for binary mixtures: Will phase separation occur during the fast transit time from the jet nozzle to the plasma? What is the time scale for phase separation/segregation?

We have not done impurity generation studies or transport analysis to the core plasma for any of the non-lithium materials. This should be done for the back up material.

Finally, a pole of experts present at the discussion indicated liquid gallium as the preferred back up material for NSTX. The voting was as follows :

Gallium 7  
Tin 1  
Tin/Lithium 1