An improved lightweight, ablative coating that may be spray applied and cured without the development of appreciable shrinkage cracks. The ablative mixture consists essentially of phenolic microballoons, hollow glass spheres, glass fibers, ground cork, a flexibilized resin binder, and an activated colloidal clay.
SPRAYABLE LIGHTWEIGHT ABLATIVE COATING

The invention described in this patent was made by employees of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties.

BACKGROUND OF THE INVENTION

1. Field of the Invention
This invention relates to insulative coatings. Specifically, the present invention relates to an improved lightweight, ablative coating that may be spray applied.

2. Background Information
This invention is closely related to the low density ablative composition disclosed and claimed in U.S. Pat. No. 4,077,921 ("921"). In fact, the present invention is an improvement on the "921 patent. Thus, the "921 patent is expressly incorporated by reference as part of the disclosure for the present invention. As stated in column 5, lines 52-55 of the "921 patent, the "921 material can be applied up to a thickness of 0.5 inch without the need for external reinforcement. However, even though the "921 material can be applied up to a thickness of 0.5 inch, the effectiveness of the "921 material is lessened when the coating thickness exceeds 0.25 inch. This reduced effectiveness is attributed to shrinkage cracks, which form from tensile stresses that develop during curing of the "921 material. The present invention overcomes the problem of stress cracking that occurs in the "921 material when the thickness of the "921 coating exceeds 0.25 inch. By controlling stress cracking, the present invention can provide better insulation to those surfaces requiring an ablative insulation coating in excess of 0.25 inch.

SUMMARY OF THE INVENTION
The present invention provides an improved lightweight, ablative coating that may be spray applied in thicknesses greater than 0.25 inch without having cracks develop from cure stresses in the material. The improvements consist of (1) replacing approximately fifteen percent (15%) of the phenolic microballoons in the "921 material with an equivalent volume of ground cork and (2) substituting a flexibilized epoxy resin binder for the epoxy-modified polyurethane resin binder used in the "921 material. Preferably, the flexibilized epoxy resin binder is manufactured by 3M Company as a two-part system known in the trade as EC2216A and EC2216B. However, other resins with similar properties may be available from other sources. The chemical composition of the 3M resin is not known because the composition of the resin is a trade secret belonging to 3M Company.

The second modification involves the substitution of ground cork for a portion of the phenolic microspheres. While the proportion of ground cork to the phenolic microspheres may vary, the best results from a curing standpoint occur when approximately fifteen percent (15%) of the phenolic microspheres are replaced by an equivalent volume of ground cork. As a result of this fifteen percent (15%) substitution, the ablative mixture preferably consists essentially of: (a) twenty-nine (29) to thirty-seven (37) percent by weight of phenolic microspheres; (b) eleven (11) to fifteen (15) percent by weight of hollow glass spheres; (c) four (4) to six (6) percent by weight of glass fibers; (d) two (2) to four (4) percent by weight of ground cork; (e) thirty-eight (38) to forty-eight (48) percent by weight of a flexibilized epoxy resin binder; and (f) two (2) to six (6) percent by weight of an activated colloidal clay.

While each of the two modifications mentioned above improve the performance of the ablative coating alone, the best results with regard to the elimination of stress cracking during cure are obtained when both the changes are made together. The ground cork also improves the thermal conductivity of the ablative coating and the strength of the char layer during ablation.

The fully cured ablative coating has a flatwise tensile strength of 60-80 psi @ 75° F. (0.41-0.55 MPa @ 24° C.), a density of 16-18 lbm./ft³ (256-288 kg/m³), a strain compatibility of 1.4-1.6%, and a thermal conductivity of 0.4 to 0.5 Btu-in./ft²-hr-°F. (5.8-7.2 mW/m-°C). The cured material also has a low flammability.

What is claimed is:

1. A composition, consisting essentially of:
   - approximately one-hundred (100) parts by weight of twenty-five (25) to sixty-five (65) percent by weight of phenolic microspheres,
   - zero (0) to twenty (20) percent by weight of hollow glass spheres,
   - four (4) to ten (10) percent by weight of glass fibers,
   - twenty-five (25) to fifty (50) percent by weight of a flexibilized epoxy resin binder, and
   - two (2) to six (6) percent by weight of an activated colloidal clay; and

DESCRIPTION OF THE PREFERRED EMBODIMENT
A preferred embodiment of the present invention consists essentially of (a) about one-hundred (100) parts by weight of an ablative mixture, and (b) two-hundred (200) to four-hundred (400) parts by weight of a solvent. The ablative mixture, in turn, consists essentially of phenolic microspheres, hollow glass spheres, glass fibers, ground cork, a resin binder, and an activated colloidal clay. The components which make up the ablative mixture of the present invention are essentially the same as described in the "921 patent except for two modifications.

The first modification involves the substitution of a flexibilized epoxy resin binder for the epoxy-modified polyurethane resin binder used in the "921 material. Preferably, the flexibilized epoxy resin binder is manufactured by 3M Company as a two-part system known in the trade as EC2216A and EC2216B. However, other resins with similar properties may be available from other sources. The chemical composition of the 3M resin is not known because the composition of the resin is a trade secret belonging to 3M Company.

The second modification involves the substitution of ground cork for a portion of the phenolic microspheres. While the proportion of ground cork to the phenolic microspheres may vary, the best results from a curing standpoint occur when approximately fifteen percent (15%) of the phenolic microspheres are replaced by an equivalent volume of ground cork. As a result of this fifteen percent (15%) substitution, the ablative mixture preferably consists essentially of: (a) twenty-nine (29) to thirty-seven (37) percent by weight of phenolic microspheres; (b) eleven (11) to fifteen (15) percent by weight of hollow glass spheres; (c) four (4) to six (6) percent by weight of glass fibers; (d) two (2) to four (4) percent by weight of ground cork; (e) thirty-eight (38) to forty-eight (48) percent by weight of a flexibilized epoxy resin binder; and (f) two (2) to six (6) percent by weight of an activated colloidal clay.

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What is claimed is:

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   - zero (0) to twenty (20) percent by weight of hollow glass spheres,
   - four (4) to ten (10) percent by weight of glass fibers,
   - twenty-five (25) to fifty (50) percent by weight of a flexibilized epoxy resin binder, and
   - two (2) to six (6) percent by weight of an activated colloidal clay; and

BRIEF DESCRIPTION OF THE DRAWINGS
Drawings are not necessary for understanding the subject matter of this invention.
two-hundred (200) to four-hundred (400) parts by weight of a solvent.

2. A composition, consisting essentially of:
   approximately one-hundred (100) parts by weight of
   twenty (20) to fifty-five (55) percent by weight of
   phenolic microspheres,
   zero (0) to twenty (20) percent by weight of hollow
   glass spheres,
   four (4) to ten (10) percent by weight of glass fi-
   bers,
   two (2) to four (4) percent by weight of ground
   cork,
   twenty-five (25) to forty-five (45) percent by
   weight of a epoxy-modified polyurethane resin
   binder, and
   two (2) to six (6) percent by weight of an activated
   colloidal clay;

one (1) to ten (10) parts by weight of an aromatic
amine curing agent; and
two-hundred (200) to four-hundred (400) parts by
weight of a solvent.

3. A composition, consisting essentially of:
   approximately one-hundred (100) parts by weight of
   twenty-nine (29) to thirty-seven (37) percent by
   weight of phenolic microspheres,
   eleven (11) to fifteen (15) percent by weight of
   hollow glass spheres,
   four (4) to six (6) percent by weight of glass fibers,
   two (2) to four (4) percent by weight of ground
   cork,
   thirty-eight (38) to forty-eight (48) percent by
   weight of a flexibilized epoxy resin binder, and
   two (2) to six (6) percent by weight of activated
   colloidal clay; and
   two-hundred (200) to four-hundred (400) parts by
   weight of a solvent.

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