Manufacturing & Prototyping

Process for Patterning Indium for Bump Bonding

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An innovation was created for the Cosmology Large Angular Scale Surveyor for integration of low-temperature detector chips with a silicon backshort and a silicon photonic choke through flip-chip bonding. Indium bumps are typically patterned using liftoff processes, which require thick resist. In some applications, it is necessary to locate the bumps close to high-aspect-ratio structures such as wafer through-holes. In those cases, liftoff processes are challenging, and require complicated and time-consuming spray coating technology if the high-aspect-ratio structures are delineated prior to the indium bump process. Alternatively, processing the indium bumps first is limited by compatibility of the indium with subsequent processing. The present invention allows for locating bumps arbitrarily close to multiple-level high-aspect-ratio structures, and for indium bumps to be formed without liftoff resist.

The process uses the poor step coverage of indium deposited on a silicon wafer that has been previously etched to delineate the location of the indium bumps. The silicon pattern can be processed through standard lithography prior to adding the high-aspect-ratio structures. Typically, high-aspect-ratio structures require a thick resist layer so this layer can easily cover the silicon topography. For multiple levels of topography, the silicon can be easily conformally coated through standard processes. A blanket layer of indium is then deposited onto the full wafer; bump bonding only occurs at the high points of the topography.

This work was done by Kevin Denis of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16386-1

Archway for Radiation and Micrometeorite Occurrence Resistance

This technology can be used where there is a need to rapidly deploy large, rugged structures including military, emergency services and disaster relief, and camping.

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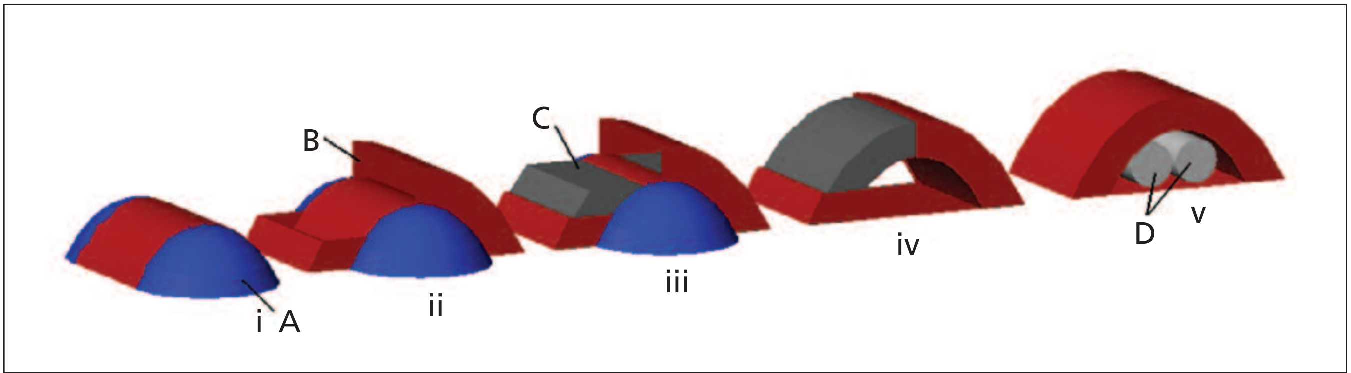
The environmental conditions of the Moon require mitigation if a long-term human presence is to be achieved for extended periods of time. Radiation, micrometeoroid impacts, high-velocity debris, and thermal cycling represent threats to crew, equipment, and facilities. For decades, local regolith has been suggested as a candidate material to use in the construction of protective barriers. A thickness of roughly 3 m is sufficient protection from both direct and secondary radiation from cosmic rays and solar protons; this thickness is sufficient to reduce radiation exposure even during solar flares. NASA has previously identified a need for innovations that will support lunar habitats using lightweight structures because the reduction of structural mass translates directly into additional up and down mass capability that would facilitate additional logistics capacity and increased science return for all mission phases. The development of non-pressurized primary structures that have synergy with the development of pressurized structures is also of interest. The use of indigenous or in situ materials is also a well-known and active area of research that could drastically improve the practicality of human exploration beyond low-Earth orbit.



Views of ARMOR Construction. The temporary inflatable (A) deploys (i). Then the jacket (B) is deployed (ii). Regolith (C) is then poured into the jacket and initially supported by the inflatable (iii). When the jacket is filled, the regolith inside the arch of the jacket is self-supporting, and the inflatable is no longer necessary (iv). Habitat modules and equipment (D) can be moved into the ARMOR (v). The jacket is shown in cutaway in steps (ii), (iii), and (iv) to illustrate regolith filling.

The Archway for Radiation and Micrometeorite Occurrence Resistance (ARMOR) concept is a new, multifunctional structure that acts as radiation shielding and micrometeorite impact shielding for long-duration lunar surface protection of humans and equipment. ARMOR uses a combination of native regolith and a deployed membrane "jacket" to yield a multifunctional structure. ARMOR is a robust and modular system that can be autonomously assembled on-site prior to the first human surface arrival.

The system provides protection by holding a sufficiently thick (3 m) arch-shaped shell of local regolith around a central cavity. The regolith is held in shape by an arch-shaped jacket made of strong but deployable material. No regolith processing is required. During the regolith filling process, an inflatable structure under the arch supports the mass of the regolith, but once regolith filling is complete the catenary arch formed by the regolith and the jacket becomes self-supporting and the inflatable can be deflated and removed. When complete, habitat modules and equipment can be moved into the protected cavity under the arch. ARMOR is a near-term system that would provide a reliable and robust lightweight structure technology to support large lunar habitats, drastically lower launch mass, and improve efficient volume use, reducing launch costs.

ARMOR also protects from micrometeorites. The kinetic energy of micrometeorites and other debris will be absorbed first by an external, high-strength blanket held over and slightly away from the ARMOR jacket. The projectile penetrates this outer blanket, but becomes fragmented and loses energy in the process. The remnants of the projectile then impact the exterior of the jacket, and the jacket and regolith absorb the remaining kinetic energy. Facilities placed inside the ARMOR will be protected from direct sunlight, reducing the extreme temperature variations. Infrared radiation from the facility will be reflected by the interior of the ARMOR back onto the facility, reducing heat loss.

This work was done by Dr. Louis R. Giersch of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). ***NPO-47686***