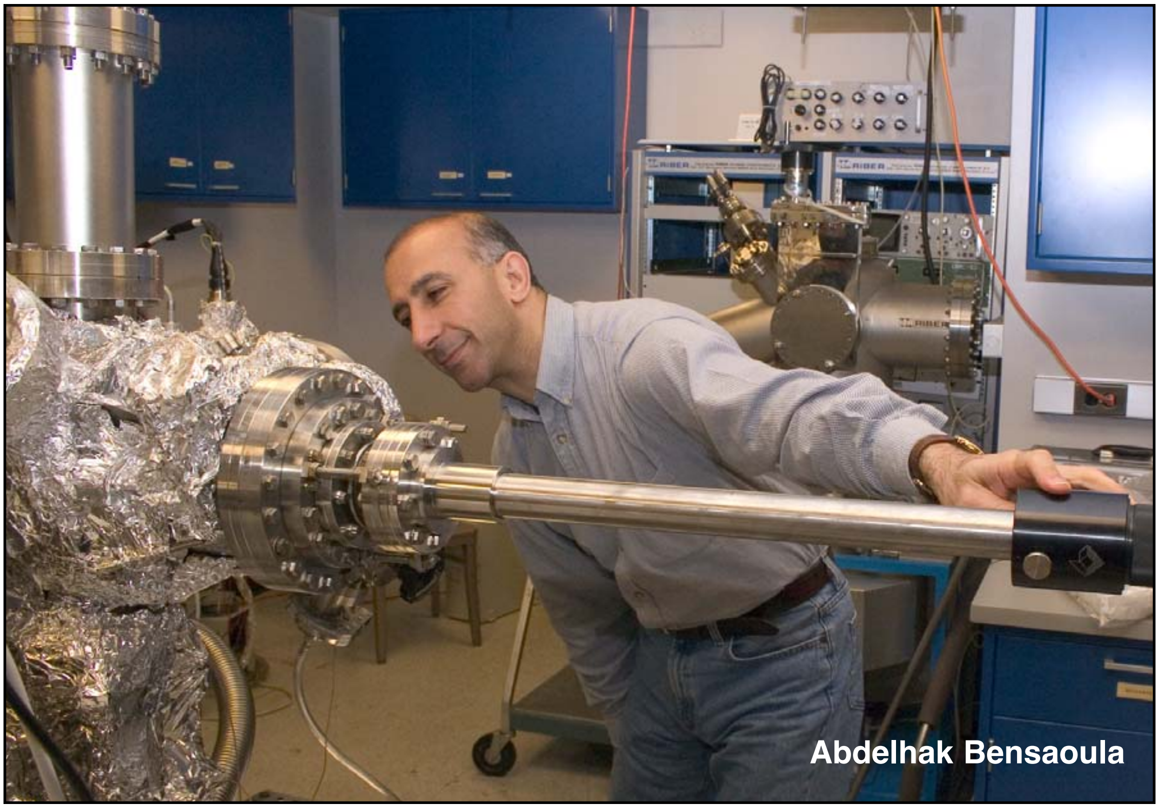


# Micro Column Arrays (MCA) for Thermal Management of Spacecraft Environments

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Thermal management of spacecraft and space station environments is an important issue in both manned and unmanned exploration of space. The process of transporting heat away from spacecraft components and bringing heat to other systems often relies on large, liquid-based heat exchange systems. Such active systems add extra weight to the spacecraft and rely on mechanical components which can malfunction, thus affecting maximum payloads and mission lifetime. A possible alternative is a passive cooling system in which thin coatings or foils would collect or remove heat by radiative absorption or emission.

A technology for the successful fabrication of Micro Column Arrays (MCAs) on thin metal foils has recently been developed in conjunction with Integrated Micro Sensors, Inc. (IMS) of Houston, TX. MCAs consist of densely packed micro cones separated by cone-shaped micro cavities and exhibit low reflectance (<0.171) and high absorbtance (>0.978) over a wide spectral range in a very close approximation of blackbody behavior. The goal of this project is to explore the use of MCA structures on metal foils for heat acquisition and/or heat rejection though their near-blackbody nature.

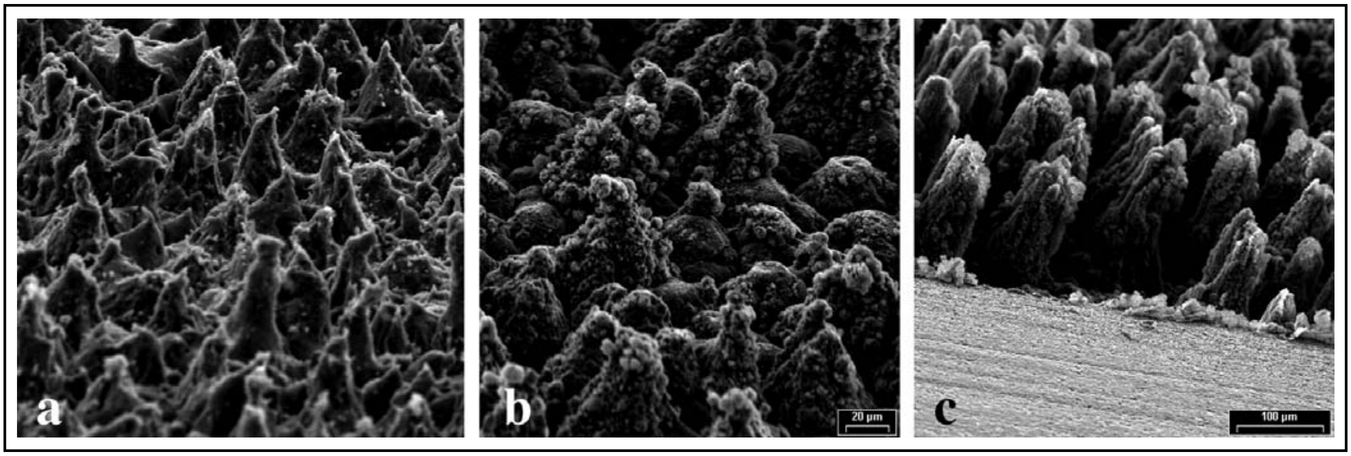


**Figure 1. MCA fabricated using the in-house facilities on (a) *Si*, (b) *Ti*, and (c) *SiC***

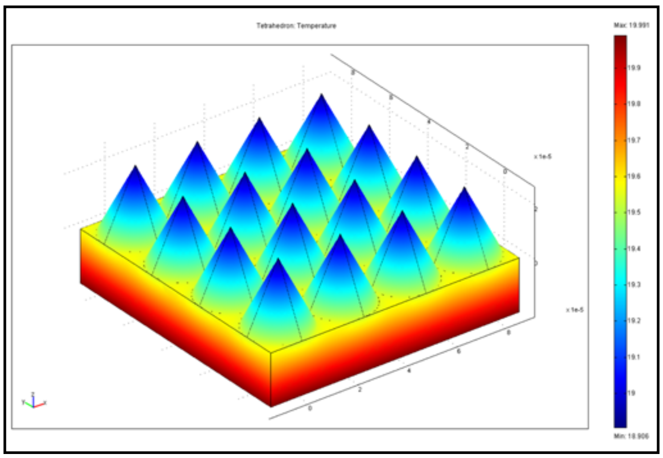

**Figure 2. A *Si*-based MCA simulation model generated in FEMLAB**

**Progress**

In the first project task, we focused on fabrication of Micro-Column Arrays (MCA) on various materials using a laser system Baasel LBI 6000 Nd:YAG Laser equipped with a NEAT computer controllable XYZ Stage. Previously, a *Cu* vapor laser system available at our Russian collaborator's facilities was used for MCA fabrication. Figures 1a, 1b, and 1c show MCA fabricated using the in-house setup on *Si*, *Ti*, and *SiC*, respectively.

The second part of our initial effort was modeling of the MCA properties using FEMLAB simulation software (Fig. 2). The model currently includes only conduction from the slab to the cones and convection from the cones to the surrounding media. We are in the process of adding radiation mechanisms. Preliminary results show a significant decrease of the slab temperature as a function of the cone size, density and geometry. These results are being utilized as feed back to the fabrication process. Prototype test structures will be measured in the near future.

**THERMAL—Dr. Nasr-Eddine Medelci-Djezzar came to the the University of Houston with a B.S. in physics from the University of Oran in Algeria and an M.S. in electrical engineering form the University of Missouri in Rolla, Missouri. He earned his Ph.D. in electrical engineering at the University of Houston and gained a position as research scientist with the Texas Center for Superconductivity and Advanced Materials (TCSAM). His work focuses upon projects concerning the thermal management of spacecraft and space station environments in both manned and unmanned exploration of space.**