CFRP Mirror Technology for Submillimeter and Shorter Wavelengths

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Composite reflector, or mirror, panels using CFRP face sheets and honeycomb aluminum core have been used on several high frequency (100 GHz - 1 THz), precision, radio astronomical telescopes since the 1980's. CMA (Composite Mirror Applications, Inc.) has been extending this technology to higher precision mirrors using CFRP in the mirror structure as well as the mirror face sheets (surface). Optical wavelength, astronomical telescope mirrors are now being fabricated up to 1.4m in diameter. CFRP has a number of advantages compared to other materials for mirrors at submillimeter through optical wavelengths: (1) It has a low coefficient of thermal expansion, comparable to glass and an order of magnitude lower than aluminum. There is minimal dimensional change even over large changes in temperature. (2) It has a high stiffness to weight ratio, enabling a very lightweight mirror. (3) The thermal conduction is very good (similar to steel and other metals). (4) The low mass and high thermal conduction result in a structure which thermalizes on a short time scale. CFRP mirror technology is well suited to use in THz instrumentation as well as for telescope mirror surfaces.

We will briefly describe the principles of mirror fabrication with CFRP technology. We will present the status and results for several CFRP mirror projects CMA has been working on during the past two year: Optical telescopes of 0.4m, 1m and 1.4m diameter, a study of composite panels for the proposed 25m CCAT submillimeter telescope, subreflectors for ALMA, APEX and ALMA-J prototype telescopes, subreflectors for the CBI telescope, telescope systems for the AMiBA project, a RICH (Ring Imaging Cherinkov optical wavelength) conical mirror of 1.3m diameter for the AMS-02 satellite scheduled for launch with the Shuttle. The surface quality, areal density, and other parameters of the mirrors will be discussed. Results of finite element analysis (FEA) are presented for several mirrors and compared to results on tested mirrors. The advantages of this technology and various risks are discussed.