ΣΥΝΘΕΤΑ ΥΛΙΚΑ ΣΕ ΑΕΡΟΠΟΡΙΚΕΣ ΚΑΤΑΣΚΕΥΕΣ: ΠΑΡΕΛΘΟΝ, ΠΑΡΟΝ ΚΑΙ ΜΕΛΛΟΝ

ΟΜΙΛΙΑ ΤΟΥ ΑΝΤΕΠΙΣΤΕΛΛΟΝΤΟΣ ΜΕΛΟΥΣ
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Κύριε Πρόεδρε,

Κύριε Γενικὲ Γραμματέα,

Κύριοι 'Ακαδημαϊκοί,

Κυρίες καὶ Κύριοι,

Εἶναι πράγματι σημαντικὴ γιὰ μένα ἡ σημερινὴ ἡμέρα ποὺ ἀνεβαίνω στὸ βῆμα τῆς 'Ακαδημίας 'Αθηνῶν, κυρίως γιατὶ ἀποτελεῖ ἕνα βῆμα μόνιμης πνευματικῆς καὶ ἐπιστημονικῆς ἐπαφῆς μου μὲ τὴν 'Ελλάδα.

'Οφείλω νὰ εὐχαριστήσω πολλοὺς φίλους καὶ συναδέλφους, ποὺ βρίσκονται ἐδῶ ἀπόψε, γιατὶ μὲ τὴν ἀγάπη καὶ τὴ συμπαράστασή τους διατήρησαν τὴν ἀγάπη μου γιὰ τὴν 'Ελλάδα, ὅταν ἀποφάσισα νὰ ἐργασθῶ ἐπιστημονικὰ στὶς 'Ηνωμένες Πολιτεῖες.

Εἰδικὰ ὅμως θέλω νὰ δηλώσω, ὅτι μὲ τὴ σημερινὴ ἐπίσημη ὑποδοχή μου, ὡς ἀντεπιστέλλοντος μέλους τῆς 'Ακαδημίας 'Αθηνῶν εἶμαι στὴ διάθεση τοῦ ἱδρύματος καὶ τῆς χώρας ὥστε νὰ συμβάλω τὸ μέγιστο δυνατὸν στὴ διάδοση τῶν βασικῶν ἀρχῶν καὶ ὑψηλῶν στόχων τους σὲ διεθνῆ κλίμακα.

Κύριε Γενικὲ Γραμματέα. Κύριε Θεοχάρη, ἀγαπητὲ συνάδελφε καὶ φίλε: Ἂν καὶ μᾶς χωρίζουν ἀρκετὰ χρόνια καὶ θὰ μποροῦσα νὰ σᾶς εὐχαριστήσω ὡς σπουδαστής σας γιὰ τὰ καλά σας λόγια, ἔρχομαι σήμερα ὡς συνάδελφος καὶ φίλος νὰ σᾶς ἐκφράσω τὶς βαθύτερες εὐχαριστίες μου γιὰ τὴν καθοδήγησή σας καὶ τὸ ἐνδιαφέρον ποὺ δείξατε στὴ δουλειά μου ἀπὸ τὴν ἀρχὴ τῆς σταδιοδρομίας μου. 'Ομολογῶ ὅτι γιὰ μένα ἀντιπροσωπεύετε τὸ ἰδανικὸ τοῦ διεθνοῦς ἐπιστήμονα καὶ καθηγητοῦ καὶ πράγματι μὲ ἐτίμησε ἰδιαίτερα ἡ προσφώνησή σας.

Σᾶς εὐχαρίστησα ἐπίσης πρὶν δύο ἑβδομάδες ὅταν ἀνέλαβα ὡς ἑταῖρος τῆς North American Thermal Analysis Society μαζὶ μὲ ἄλλους συναδέλφους ποὺ ἐπίσης γνωρίζετε. Καὶ σήμερα θὰ πρέπει νὰ εὐχαριστήσω αὐτοὺς τοὺς συναδέλφους ἀπὸ ὅλον τὸν κόσμο, ποὺ μὲ τὴ φιλία καὶ τὴ συνεργασία τους συνετέλεσαν καὶ συντελοῦν στὴ διεθνοποίηση τοῦ ἐπιστημονικοῦ μου ἔργου.

Δὲν νομίζω ὅτι ἡ σημερινὴ τιμητικὴ ἐκδήλωση θὰ ἦταν δυνατὴ χωρὶς τοὺς φοιτητὲς καὶ συνεργάτες μου, ποὺ ἀπετέλεσαν καὶ ἀποτελοῦν τὴ βάση τοῦ ἐρευνητικοῦ

μου ἔργου. Ἰδαιαίτερα οἱ Ἕλληνες φοιτητὲς καὶ ἀπόφοιτοι κ.κ. Χ. Βελισάρης, Κ. Κεφαλᾶς καὶ Λ. Γεωργούλης ἔχουν σήμερα τιμητικὴ θέση ἀνάμεσα στοὺς συναδέλφους τους.

Πρὶν εἰσέλθω στὸ θέμα τῆς ὁμιλίας μου, ποὺ ἀφορᾶ τὰ σύνθετα ὑλικὰ σὲ ἀεροπορικὲς κατασκευές, θὰ πρέπει νὰ ἀναφερθῶ στὴ μνήμη τοῦ πατέρα μου Κωνσταντίνου Σεφέρη, χημικοῦ, ποὺ μὲ ἔκανε νὰ ἀγαπήσω τὴν ἐπιστήμη μου σὰν εὐχάριστη ἀπασχόληση (hobby). Ἐπίσης στὴ μνήμη τῆς ἀδελφῆς μου Μάνιας ποὺ τῆς ὀφείλω τὴν ἀρχὴ τῶν σπουδῶν μου στὴν Ἀμερικὴ ἀλλὰ καὶ ποὺ ὡς καθηγήτρια τῆς ψυχολογίας μὲ βοήθησε νὰ συνειδητοποιήσω πόσο σημαντικὸ εἶναι γιὰ ἕνα ἐπιστήμονα νὰ λαμβάνει ὑπ' ὄψιν του τὶς ἀνθρώπινες σχέσεις.

Τέλος γιὰ τὴ φιλοσοφικὴ ἐνατένιση τῆς ἐπιστήμης μου καὶ τῆς ζωῆς μου θέλω νὰ εὐχαριστήσω τὴ μητέρα μου ποὺ παρευρίσκεται σήμερα στὴν τελετὴ αὐτὴ καὶ νομίζω, ὅτι οὐσιαστικὰ τῆς ἀνήκει ἡ τιμή.

Μπαίνοντας στὸ θέμα μου, γιὰ τὰ ὑλικὰ ὑψηλῆς τεχνολογίας, πρέπει νὰ παραδεχτῶ ὅτι ἔχω ἕνα δίλημμα. Ὡς Ἕλλην ποὺ μὲ γνωρίζετε ἐλπίζω νὰ μιλάω ἁπλὰ καὶ καθαρὰ ἑλληνικά. Ἀλλὰ ὡς καθηγητὴς Πανεπιστημίου στὴν Ἀμερικὴ διατυπώνω τὶς σκέψεις μου Ἀγγλικά. Δὲν μοῦ ταιριάζει καθόλου νὰ μιλήσω στὸν τόπο μου Ἀγγλικὰ καὶ παρακαλῶ, Κυρίες καὶ Κύριοι, νὰ δείξετε κατανόηση ἂν κάνω μερικὰ συντακτικὰ λάθη ἢ χρησιμοποιῶ Ἀγγλικὲς λέξεις. Καταλαβαίνετε ὅτι ἡ δουλειά μου καὶ ἡ ἐπιστήμη μου ἀπαιτοῦν μία παγκόσμια σχέση θετικῶν ἐπιστημῶν, τεχνῶν καὶ φιλοσοφίας, ποὺ ἁρμόζει ἀπόλυτα στὴν Ἀκαδημία Ἀθηνῶν. Γι' αὐτὸ κιόλας ἐλπίζω ὅτι οἱ συνάδελφοι θὰ μοῦ συγχωρέσουν τὴν κατάθεση στὰ Πρακτικὰ τοῦ τεχνικοῦ κειμένου στὰ Ἀγγλικά.

Advanced composite materials offering weight saving over traditional materials of airplane construction are opening a new era in modern aviation. Wood and canvas, however, may be considered the first modern-day composite that offered the early airplane design pioneers both structural and aerodynamic efficiency. As can be seen in Figure 1, large scale manufacturing, albeit labor intensive, was possible in the early part of this century.

Indeed, with the development of advanced composites in the 1960's using primarily fiberglass as the reinforcing fiber held together by an epoxy based polymer, these labor intensive practices were revived since they offered potential cost-effective manufacture, especially of secondary airplane structures (1). This was the practice that was continued with the development of advanced composites in the 80's where more exotic fibers such as carbon and Kevlar® offered increased load bearing capability while at the same time reducing weight requirements. As can be seen in Figure 2, these advanced composites

have been in service in basically every new aircraft developed in the 1980's with excellent results.

The development of advanced composites followed the experience with plywood as a material for airplane construction. Thus, high performance composites have focused on the creation of laminated layered structure. Each layer made of unidirectional or woven fibers is laid on the preceding one at a specific orientation so as to provide specific properties where they are needed in a light-weight planar construction. Each individual ply called the prepreg (as shown in Figure 3) is made up, then, of the reinforcing fibers held together by the matrix which has to be flexible enough to allow shaping as well as adhesion once each prepreg ply is set for making a part. Once the part is shaped, it is formed into final form with the application of heat and pressure provided by an autoclave or a press. The type of matrix used basically dictates the processing conditions to be employed. Currently, all advanced composites in use today on commercial aircraft employ a thermosetting polymer as the matrix, usually an epoxy. However, as future airplanes are planned, changes in matrix materials are anticipated. Indeed, our fundamental research had anticipated such requirements (1, 3).

Our research over the past ten years has focused on identifying the role that the polymer matrix plays in the utilization of advanced composites. Figure 4 shows several polymer matrix systems currently under study in my laboratory. Both thermoplastic and thermosetting polymers are being considered, especially for increased temperature performance and toughness. These requirements are dictated by the antipated future aircraft developments.

Specifically, as we look into the future, we expect larger load bearing structures to be made out of composites requiring increased resistance to damage, i.e., damage tolerant. This tolerance must be provided by the matrix either in its pure form or as a blend that may involve a mixture of thermoplastic/thermosetting polymers properly placed in the composite. Indeed, recent developments, both in understanding the manufacturing of prepregs (2) and the functional requirements of laminates, have led us to the development of model matrix layered structures as shown in Figure 5 (3). Such systems made of matrices that are blends of thermosets and thermoplastics offer an evolutionary methodology for advanced composite development. This evolutionary approach is ideally suited for airplane development since previous experience with material utilization is essential for reducing the risk for future applications.

The 1990's promise to be quite exciting with the development of several subsonic commercial aircraft as well as supersonic requiring temperature performance that goes beyond the performance of epoxy matrices used in traditional aircraft designs. The model layered composite structure that we have successfully developed in the laboratory

simulating several commercial systems under development promises to identify several fundamental requirements that must be met for effective composite utilization in the aircraft environment.

Indeed, as can be seen in the micrograph of Figure 6, this system, albeit simple in appearance, provides quite a challenge in its analysis. It should be emphasized that in analyzing and developing advanced composite systems, an integrated view point must be adapted. As shown in Figure 7, this view point requires integration of skills from basic research to applied developments. We are currently in the process of developing scaling concepts for heterogeneous anisotropic and viscoelastic materials that promise to provide a basic understanding of advanced composites in order to be used cost effectively in future airplane development.

The past has been educational, but the future promises to be exciting.

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