The Application of Advanced Materials to De-Icing Microwave Communications Antennas in Labrador, Canada

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❐ Résumé

Les tours de télécommunications micro-ondes du Labrador sont exposées au verglas, dont l'accumulation sur la couverture de l'antenne excède parfois une épaisseur de 1.5 m. Cette situation entraine une perte importante du signal. Il existe donc un besoin urgent d'aborder ce problème dans une région où les télécommunications constituent l'unique lien avec le monde extérieur.

❐ The Project

NewTel Communications has experienced severe icing on its microwave towers located in Labrador. Such high build-ups of rime ice can cause loss of communications. The worst sites are located at Sand Hill near Cartwright, and at Monkey Hill near Makkovik, where rime ice thicknesses in excess of 1.5 m have been measured. Figure 1 shows the ice accumulation on the tower at Monkey Hill in January 1998.

Figure 1.
Rime ice accumulation on microwave antennas at a site in Labrador (courtesy of NewTel Communications)

NewTel has upgraded its facilities to operate at 6 GHz, up from the current 900 MHz, and this increased frequency is of concern since the decreased wavelength will likely result in an increased sensitivity to ice accumulations. C-CORE is currently designing and installing a mechanical system to prevent accumulation of ice on radomes and will also install a test panel at Monkey Hill to evaluate the capability of various advanced materials to hinder the formation of ice on their external surfaces. These are called the 'ice-phobic' properties. Test samples have been by space companies in Canada and Europe. In addition, in the near future, the electromagnetic transmissivity of these materials will be measured over the frequency range 900 MHz to 6 GHz. The propagation of microwave signals through ice of various thickness has already been characterised over this range of frequencies. Personnel from Daimler-Benz have asked to participate in the project in Labrador.

Figure 2 shows snow and ice accretions on some of the material samples obtained from Daimler-Benz and RST Systemtechnik, Diavac and Cametoid Ltd. These samples are listed in Table I.

Rime ice and snow were generated in C-CORE's cold room

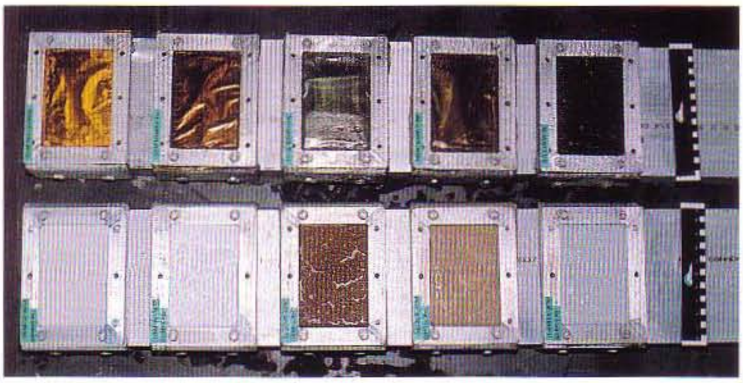

Fig. 2a

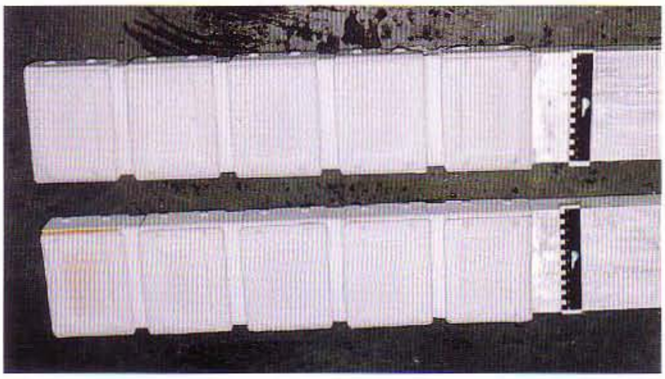

Fig.2b

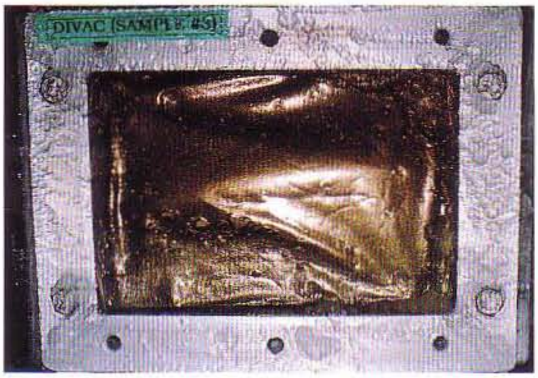

Fig. 2c

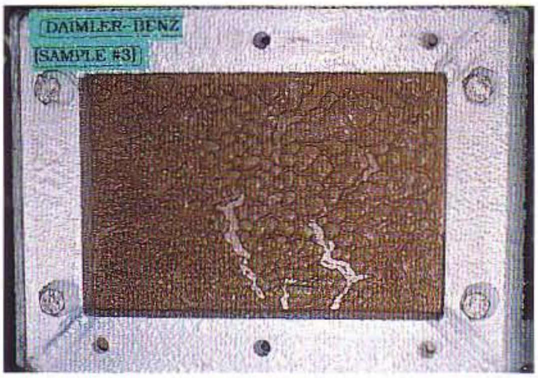

Fig. 2d

Fig. 2e

Fig. 2f

Figure 2. ▲ ▶
Advanced materials, with ice-phobic properties subjected to ice and snow accretions in the laboratory.
(a) and (c) - (f) Test panels with 0.125 inches rime ice.
(b) test panels with snow.

Table 1. List of samples obtained to date

COMPANY	MATERIAL TYPE	COMMENTS
Cametoid Ltd. (CDN)	Caption coated aluminium	Flexible
Raumfahrt System-technik GMBH (D)	Loran-S	Rigid
Daimler-Benz (D)	PTFE coated glass fabric	Flexible
	PTFE coated PTA fabric	Flexible
	TFM coated glass fabric	Flexible
	TFM coated aramide fabric	Flexible
	Fluor-elastomer coated glass	Rigid
Diavac ACM Ltd. (UK)	DLC coated Mylar film:	All samples are flexible
	5 min at 200V one side	
	20 min at 200V one side	
	5 min 300V one side	
	10 min 300V one side	
	5 min 300V both sides	

where the ice-phobic properties of a number of candidate materials were tested. The ice-phobic properties of these materials were measured through a simple scratch test. Results are shown in Figure 3.

Installation of the test panel at Monkey Hill was delayed due to a freak ice storm in early March 1998 which caused some of the antennae on the tower to break away. Winds of over 200 km/hr were experienced. Figure 4 shows the damaged microwave tower at Monkey Hill, Labrador. Huge ice build-up and high winds caused the upper antennas to break away during a storm in early March 1998.

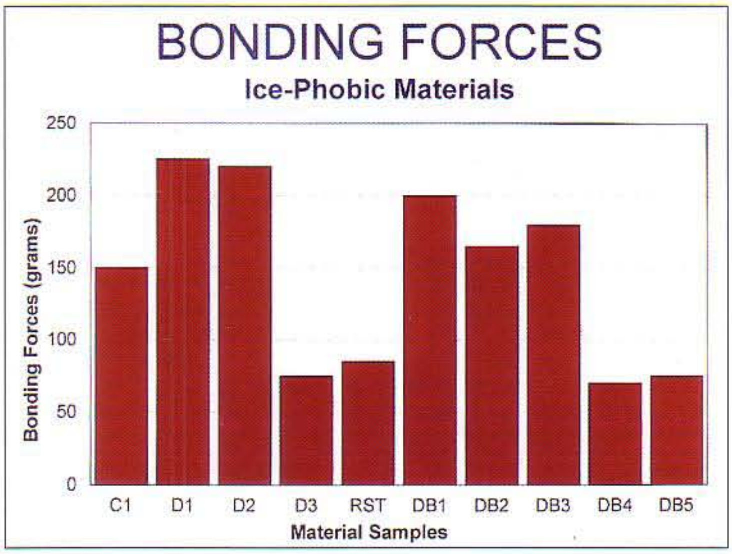

Figure 3.
Ice-phobic properties of the sample materials.

❐ The advanced materials

Daimler-Benz provided samples of both flexible and rigid materials with ice-phobic coatings. Diavac provided diamond-like carbon, ultra-thin coatings deposited on mylar sheets under varying temperature and vacuum conditions. RST Systemtechnik provided a rigid material while Cametoid Ltd. provided a vacuum deposited coating on a flexible substrate. The partners in the project are listed in Table 2.

Table 2. Partners in the project
Daimler-Benz (D)
RST Systemtechnik (D)
Diavac (UK)
Cametoid (CDN)
NewTel (CDN)
Chevron Canada (CDN)
C-CORE (CDN)
ESA

❐ Conclusions

This project is still ongoing and the test materials will be evaluated during the winter 1998/99 season. It is worth noting that these same materials have been installed on a Super Puma helicopter to evaluate how they inhibit the accumulation of ice in-flight. They will also be installed on a drilling ship operating in the Grand Banks over winter. If all these trials are successful it will open up new markets for application of these materials to arctic installations, helicopters, fixed wing aircraft, ships and oil rigs (Chevron Canada has expressed keen interest in testing out some of the ice-phobic materials on their exploration well drilling ships or rigs) where freezing ocean spray is a major problem.

Figure 4.
A microwave tower damaged by the combination of a massive ice build-up and high winds, which caused the upper antennas to break away during a storm in early March 1998. (courtesy of T. Vary, P. Eng. Varian Inc.)