

## High Temperature Resistant Phthalonitrile Resins

There are many high temperature thermosetting resins which are currently being utilized in aerospace industry like epoxy, phenolics, PMRs, cyanate esters and bis-maleimides for structural and specialty applications. These resins have their own limitations and drawbacks as epoxy and phenolics have poor shelf-life at room temperature and have to be stored at sub-zero conditions and that too for a limited period. PMR and bis-maleimides have issues related to their processability while cyanate ester are highly prone to hydrolysis due to presence of labile cyanate functional group (-OCN) although they show good thermal and dielectric properties at elevated temperature. Epoxy resins are not used for high temperature applications although they have good processability due to flexible aliphatic chains present in glycidyl-ether linkage. Phenolics and PMR resins also have issues related to toxic volatiles leading to volume shrinkage so have limited processing methods for fabrication of composites. Aromatic bismaleimides although have high temperature stability and high glass transition temperature but they are difficult to process. Aliphatic bismaleimides show poor isothermal properties at elevated temperature due to decomposition of aliphatic backbone.

DMSRDE, Kanpur has developed high char yield and low dielectric constant phthalonitrile resins to overcome above concerns especially for continuous usage at high temperature, high glass transition temperature. These properties are inherently due to highly aromatic skeleton of cross-linked network.

### **Application of Phthalonitrile Resin**

Phthalonitrile resins are potential candidates for applications where it can be used as a matrix resin for fabrication of composites structures in place of currently used phenolic and epoxy resins on account of room temperature storage of monomers, high temperature stability, high glass transition temperature, low dielectric constant and high char yield of cross-linked polymer. The resin alone can also be used for ablative coating material for surfaces on account of high char yield.

Interested industries are requested to submit their financial bid in sealed envelope, along with relevant documents as per the list in appendix-A, through one of the following agencies only, to DRDO before the bid ending date:-

<b>S. No</b>	<b>Name of the Agency</b>	<b>Point of Contact</b>
1	<b>National Research Development Corporation</b> Address :20-22, Zamroodhpur Community Centre, Kailash Colony Extn. New Delhi - 110048	Sh. Rajendra Gondane Sr. Manager (Business Development) National Research Development Corporation 20-22, Zamroodhpur Community Centre, Kailash Colony Extn. New Delhi - 110048 INDIA

	<p>Tel : +91-11-29240401 to 29240407  Fax: +91-11-29240409 / 29240410  General E-mail : write2[at]nrdc[dot]in</p>	<p>Mobile : +91-9910496554  EPABX : +91-11-29240401-07 (Extn. 444)  Fax : +91-11-29240409 -10  Email : rgondane[at]nrdc[dot]in  Website : www[dot]nrdcindia[dot]com</p>
2	<p><b>PHD Chamber of Commerce and Industry</b>  Address: PHD House, 4/2 Siri Institutional Area,  August Kranti Marg, New Delhi 110016</p> <p>Tel : 91-11-26863801-04, 49545454  Fax : 91-11-26855450, 49545451  Website : <a href="http://www.phdcci.in">www.phdcci.in</a>  E-mail : phdcci[at]phdcci[dot]in</p>	<p>Nasir Jamal  Joint Secretary  PHD Chamber of Commerce &amp; Industry  Address: PHD House, 4/2 Siri Institutional Area,  August Kranti Marg, New Delhi 110016  INDIA</p> <p>Mobile : +91-9810185714, 8210343267  Phone : +91-11-49545454, 49545400 Extn : 279  Fax : +91-11-26855450</p>
3	<p><b>Confederation of Indian Industry (CII)</b>  Address: The Mantosh Sondhi Centre  23, Institutional Area,  Lodi Road, New Delhi - 110 003  (India)</p> <p>Tel : 91 11 45771000 / 24629994-7  Fax : 91 11 24626149  E-Mail : info[at]cii[dot]in  Website : <a href="http://www.cii.in">www.cii.in</a></p>	<p>Amit Kumar  Deputy Director – Defence &amp; Aerospace  Society of Indian Defence Manufacturers (SIDM)  C/o Confederation of Indian Industry (CII)  Address: 3rd Floor, IGSSS, 28 Institutional Area,  Lodhi Road, New Delhi – 110003  INDIA</p> <p>Mobile : +91-9990059163  Phone : +91-11-45772062  Fax : +91-11-45772022  Email : amit[dot]kumar[at]cii[dot]in  Website : <a href="http://www.sidm.in">www.sidm.in</a></p>
4	<p><b>The Associated Chambers of Commerce and Industry of India (ASSOCHAM)</b>  4th Floor, YMCA Cultural Centre and Library Building,  01, Jai Singh Road, New Delhi - 110001</p> <p>Phone: 46550555 (Hunting Line)  Fax: 01123347008/9  Website :www[dot]assocham[dot]org</p>	<p>Ms Kavita Sharma  Addl Director and Head - Energy and Infra  Mobile : 09871801002  Tele: 0091-11-23347040  Email: kavita[dot]sharma[at]assocham[dot]com  Website : <a href="http://www.assocham.org">www.assocham.org</a></p>

**List of Support documents to be attached**

- (a) Memorandum and Articles of Association (Should be incorporated as per Indian Companies Act, as amended time to time)
- (b) Certificates of registration as a manufacturing unit, if any.
- (c) Audited Balance Sheet for the preceding three years.
- (d) Income Tax returns for the preceding three year period
- (e) Details of shareholding/ownership pattern especially foreign partners/ shareholders, foreign employees, directors, etc. The company must adhere to the prevailing Govt of India policies and regulations on Foreign Direct Investment (FDI)/DIPP norms as applicable.
- (f) Annual budget for R&D during last three years.
- (g) Numbers and details of IPR or patents, etc., held by the company.
- (h) Number of technically or professionally qualified personnel.
- (i) Record of past performance (e.g., Supply orders executed against of Ministry of Defence orders, Public Sectors and Paramilitary Forces, if any).
- (j) Availability of adequate infrastructure (List of machines and their production capacities) and technical expertise.
- (k) List of Testing and Support equipment's
- (l) ISO/ ISI certification or any other certification
- (m) Relevant clearances form the authorities/ ministries (if any)
- (n) Capacity and capability to undertake developmental work and to accept attendant financial and commercial risks.
- (o) Capacity/capability to market the product through the marketing network, sales and service network, reliability to maintain confidentiality.
- (p) PESO and DPIIT license for explosive handling if ToT is for high energy Material, explosives, propellants, and component/ system dealing with it etc.
- (q) Under taking form company seeking ToT that none of its Directors, Independent Directors, non-executive Directors, Key management personnel are involved in any corrupt practices, unfair means and illegal activities.
- (r) Details of the industrials license for defence manufacturing be provided by the industry seeking ToTs.