

Research on Curing Determination and Testing Methods of Epoxy Encapsulation Materials

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Abstract:

For epoxy potting materials, both their mechanical strength and adhesive properties are very beneficial, and they also have extremely strong electrical insulation capabilities, which can fully meet the requirements of potting electronic devices to resist various harsh and complex environments. So in the development process of some industries with high reliability requirements, resin sealing technology has been widely applied. In the design and sealing process, epoxy sealant material will be used. To avoid any problems with poor curing effect, curing determination work should be carried out and scientific testing methods should be implemented. Only in this way can the sealing status be clarified and the final sealing quality be ensured.

Keywords:

Epoxy Grouting Material, Solidification Determination, Test Method

1. Introduction

In the process of development in the new era, technology is constantly advancing and improving, especially in the field of electronic technology, which is presenting a completely new look. The corresponding electronic sealing materials also need to be improved and perfected synchronously. Among large-scale grouting materials, epoxy grouting materials are widely used in the semiconductor field due to their high heat resistance and low shrinkage, which can maintain high stability during operation. Epoxy sealing materials are of utmost importance, and it is necessary to do a good job in curing determination. At the same time, the most advanced testing methods should be introduced to control the details and key points, in order to improve the effectiveness of testing and ensure the reliable and accurate quality of the material. [1]

2. Curing Determination and Detection Targets of Epoxy Sealing Materials

Conduct scientific testing on the curing state of epoxy sealing materials and clarify the criteria for judgment. In the specific testing experiment process, E51 material is selected and a certain amount of filler is synchronously added, scientifically proportioned to finally form the sealing adhesive raw material. During the sealing process, a certain proportion of curing agent needs to be added to the fully proportioned raw materials, and the testing personnel should stir thoroughly and evenly before proceeding with the subsequent sealing operation. Throughout the entire process, the testing personnel should closely observe the curing process, accurately record the numerical forms, determine the judgment method after curing, and use this as the basis for testing and provide data support. [2]

During the testing experiment, when determining whether the epoxy sealant has cured, the DSC method needs to be applied and confirmed. Because the material exhibits an exothermic reaction state during the curing process, the DSC method can be applied in the initial stage of mixing raw materials and curing agents, while maintaining a constant temperature change and continuously heating the sample. Based on the final exothermic value, the curing degree can be accurately determined. However, from another perspective, there is a drawback in the application process of this method, which is that it is not convenient and concise to operate, and detection activities must be carried out at the beginning of the proportioning stage. Most of the testing steps currently implemented do not cover the entire curing process, but only detect the final curing state. Therefore, it is necessary to explore more convenient and efficient testing methods. The most direct way to present the degree of solidification is to integrate mechanical methods for scientific testing. Specifically, strictly follow the hardness index and substitute the curing degree with the hardness of the test samples. There are many common hardness testing methods in reality. For example, Luo style, hard style, and so on. By scientifically analyzing the hardness testing methods and combining them with the characteristics and size of the fully cured material, the most suitable testing method can be selected. Standing at a macro level, scientifically judging and analyzing the object being tested, and integrating the performance of the cured material and the on-site environment, more accurate and efficient inspection methods can be obtained. Not only can it enhance the final production and manufacturing effect, but it can also scientifically judge the final curing condition of the tested materials, achieving the expected goals. [3]

2.1. Main raw materials and instruments and equipment

Firstly, select E51 bisphenol type epoxy resin material, combined with 593 curing agent and boron nitride filler. You also need to choose phthalocyanine blue pigment. Authoritative manufacturers should be selected for the selection of different materials; Secondly, during the entire curing determination and testing process, a handheld hardness tester should be selected, along with the use of a scanning calorimeter; Finally, the mold tooling. That is to say, based on the specific shape of the sealed product, prepare a mold with a diameter of 5cm to meet the production requirements of the sealed sample. [4]

2.2. Preparation of standard samples

In the process of making standard samples, specific proportions should be set according to the requirements, and the epoxy resin material, filler, and pigment should be mixed evenly by manual stirring to obtain the mixture. Throughout the entire

mixing process, one direction should be maintained and the control time should be three minutes. After sufficient and complete mixing, it can be used as a backup sealant. After analysis, it can be clarified that the sealing material cannot be fully cured at this time, and a curing agent should be added to ensure that the sealing material can continue to cure. In the process of making standard samples, the pre prepared epoxy resin sealant and curing agent should be thoroughly mixed, and the mixing process should follow the specified ratio while uniformly stirring. Subsequently, these materials need to be poured into the mold. During the entire testing experiment, three sealed standard parts should be prepared, and before the mold is put into use, a release agent should be applied for brushing to ensure that it is completely cured before it can be directly removed. [5]

2.3. Sample hardness measurement

For the hardness tester used in the application, it is necessary to follow relevant specifications and standards for use, and clarify the specific requirements of the sample. The specific measurement method is as follows: the responsible personnel should prepare a hard platform and place the standard sample on it comprehensively. The hardness tester should be controlled by hand, and the distance between the indenter and the edge of the sample should be strictly controlled to be at least 6mm. Then press it steadily onto the sample. At this point, press the pressure needle vertically into the sample until the final pressure foot can fully contact the sample, and perform rapid and accurate readings within 1 second of contact. Throughout the process, testing should be conducted at different locations, with a controlled number of 5 tests. The final hardness value of this sample can be obtained by averaging the values obtained from the 5 tests. [6]

For these three standard samples, conduct DSC analysis step by step. After placing the standard sample, it should be heated appropriately and follow a heating rate of 20 degrees Celsius per minute. The final temperature should be raised from the base room temperature to 230 degrees Celsius. At this point, the testing personnel responsible for the experiment should comprehensively collect the final heat release data of the standard sample. Based on the heat release and total reaction heat, the final curing degree of three standard parts can be obtained. For the standard sample, a hardness tester is then used for detailed measurement, and targeted testing is carried out based on the previously distributed 5 points. The final average hardness value obtained is the final hardness value of the known curing state. [7]

Based on the analysis of the testing experiment, a conclusion can be drawn that the hardness of the final sealant can be determined by measuring the hardness of the standard component.

2.4. Determine the curing time

Based on the hardness value, reverse the curing time and prepare a set of standard samples using the same method. Subsequently, hardness measurement work was carried out using a hardness tester measurement method based on changes in time. Based on the time variable background, hardness testing was conducted on three standard components, and it was found that the hardness value after curing had been reached within the first 8 hours. However, as time passed, after more than 8 hours, the overall hardness value did not change significantly and showed a stable development trend. Moreover, according to the chart analysis, the hardness changes relatively significantly and rapidly in the first eight hours, but after eight hours, the overall

hardness has not changed much and remains above 80HD. From this, it can be concluded that strictly following the relevant process document standards can achieve the optimal curing state within 8 hours. [8]

2.5. Comparison of surface hardness and internal hardness

In the process of conducting hardness testing, it is necessary to choose to test on the surface, and whether the final hardness value represents the overall hardness after sealing should be further verified through refinement. Therefore, during the configuration process of the second group of samples, it is necessary to conduct comprehensive measurements of surface and internal hardness after 8 hours of configuration. After the surface hardness measurement is completed, it is necessary to completely cut open the middle part and measure the hardness of the internal position for comparison. [9]

It can be understood that regardless of any sample, the surface hardness is greater than the internal hardness, but the overall hardness value meets the standard of being completely greater than 80HD, and there has been no situation where the hardness value is less than this value. It can be clarified that after the epoxy potting material is fully cured, only surface hardness testing can represent the overall hardness, so there is no need for internal hardness testing. The final overall hardness value can be determined directly based on the hardness value obtained from surface testing. [10]

2.6. Testing precautions

Firstly, to ensure that the entire testing process is not affected by too many factors and to guarantee the accuracy and scientificity of the final testing results, it is necessary to strictly follow industry standards, implement the testing content, and avoid any related discrepancies. At present, there are relatively many methods for curing testing of epoxy potting materials, such as thermal analysis, hardness testing, etc. Different methods require strict control of the specific testing process and compliance with relevant national standards to avoid testing deviation issues; Secondly, during the detection process, according to the predetermined detection method, highly accurate and stable detection equipment should be selected first, and comprehensive verification should be carried out before detection to ensure that everything is foolproof. Only in this way can the final detection accuracy be guaranteed. The testing activities implemented in this article mainly involve the application of standard Shore hardness tester equipment; Again, it is about controlling the detection environment. In the progress of testing activities, the testing environment is of paramount importance. The responsible testing personnel should strictly follow the testing requirements, scientifically control the testing material environment, not only strictly regulate the temperature and humidity, but also ensure the cleanliness and tidiness of the testing environment, which will not be affected by any external factors, resulting in a significant reduction in the accuracy of the final testing results; Finally, it is about scientifically processing and analyzing data. In the progress of testing activities, a large amount of data will be generated, which is the key to determining the curing degree and final performance of the final epoxy sealing material. Therefore, scientific data processing methods should be implemented for these data, such as statistical analysis methods, regression analysis methods, etc. Only in this way can we deepen the mining and detection data, and obtain the most scientific and accurate conclusions. [11]

3. Conclusions

In summary, under the development background of the new era, comprehensive curing determination and testing work should be carried out for epoxy sealing materials to obtain the final testing values, which can ensure the quality and performance of the final product. Therefore, there should be no carelessness in the curing determination and testing process. This article focuses on an in-depth analysis of the curing state of the sealed samples, using hardness values as the main basis to scientifically judge the degree of curing. In the testing process, the preferred measurement system analysis method is to obtain a hardness value completely greater than 80HD through multi-party comparison and verification, which can achieve a fully cured state. In the future development process, technology will continue to advance, industrialization level will also continue to improve, and the corresponding application scope of epoxy sealing materials will continue to expand. Therefore, higher requirements will be put forward in the process of curing judgment and testing methods implementation, and more advanced technologies will be introduced to meet new requirements. So relevant institutions need to continuously increase their research and development efforts, explore new technologies and models, and promote the continuous progress and breakthroughs of epoxy encapsulation material technology.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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