J-integral vs. CBBM in mode I fracture analysis of adhesive joints

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INTRODUCTION

Adhesive bonds have received increasing interest due to its advantages over classical joining techniques, such as reduced weight, broader material, improved stress distribution and enhanced resistance to high dynamic loads. Damage analysis is done to understand the failure mechanisms and their safety limits. The fracture energy of the adhesive is a key parameter in characterizing this and can be evaluated by various data reduction methods. Our research focuses on the comparison between the Compliance-Based Beam Method (CBBM) and J-integral across a range of adhesives, from brittle to very flexible.

METHODS

The fracture energy is obtained by mode I fracture tests conducted under a quasi-static deformation rate of 0.2 mm/min and room temperature. The CBBM is a data reduction method that utilizes the compliance of the substrates and an equivalent crack size to determine the fracture energy. J-integral is a direct method that determines the fracture energy from the load and the rotation of the substrates. The fracture energies are compared to the adhesive parameters in order to provide valuable insights into their performance. Figures 1 and 2 introduce the seven different adhesives, including three different family types, that are considered in this research.

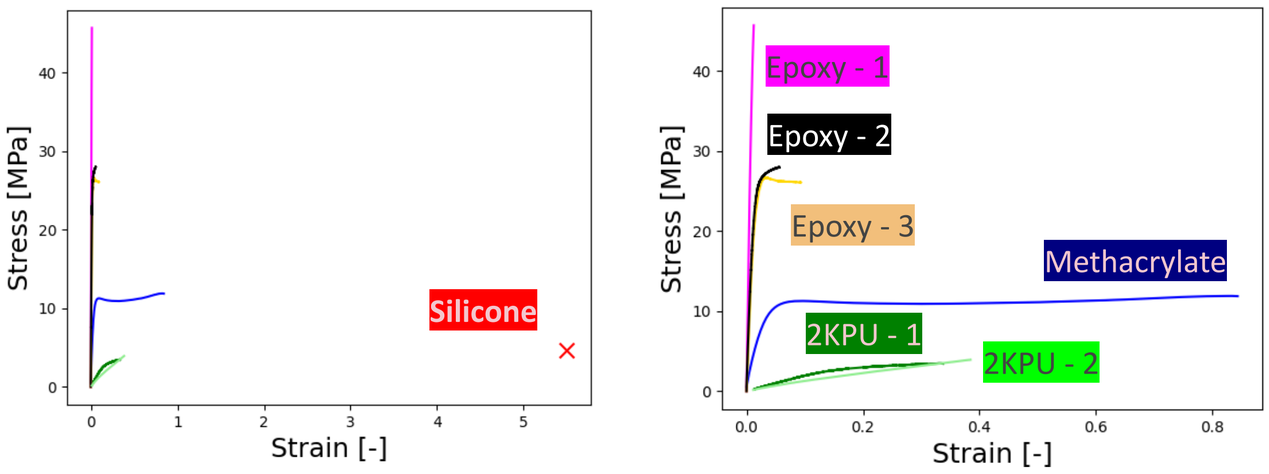

Figure 1 – Stress strain curves. a) for all the adhesives, b) zoomed view of figure 1a.

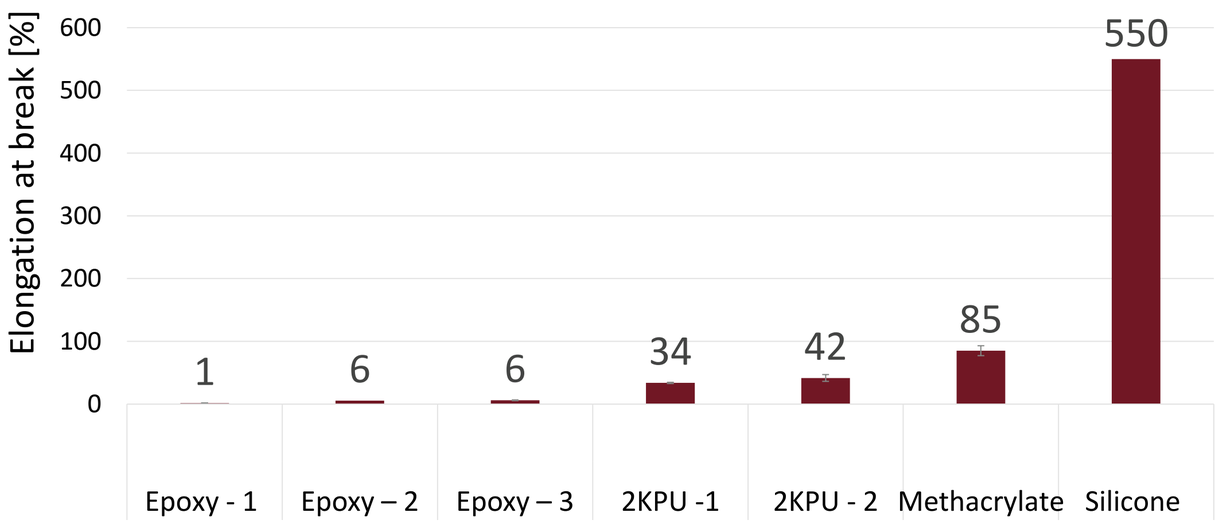

Figure 2 – Elongation at break for each adhesive.

RESULTS

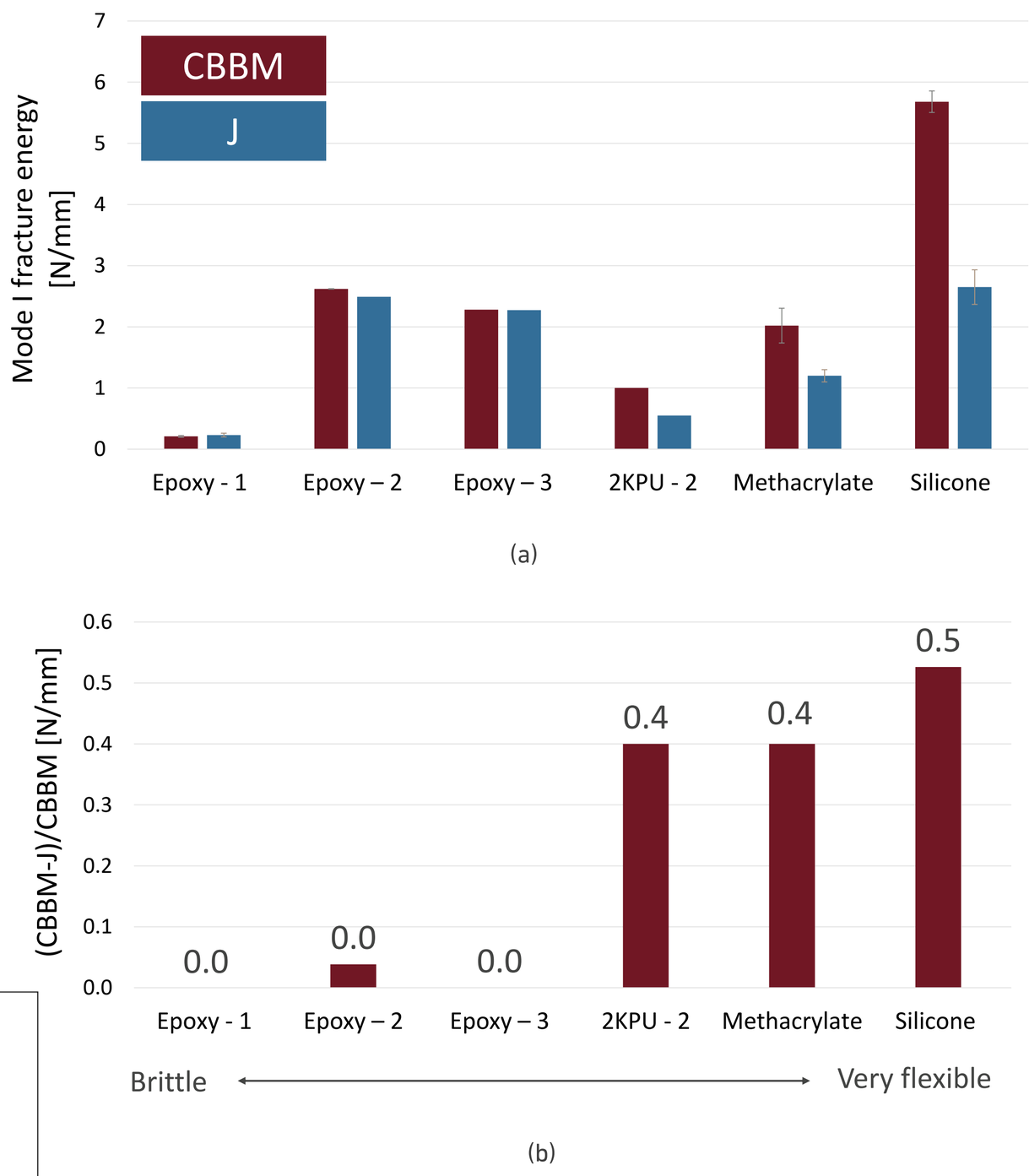

Figure 3 – Mode I fracture energy results. a) CBBM and J comparison for every adhesive, b) the normalized difference in fracture energy between CBBM and J.

CONCLUSION

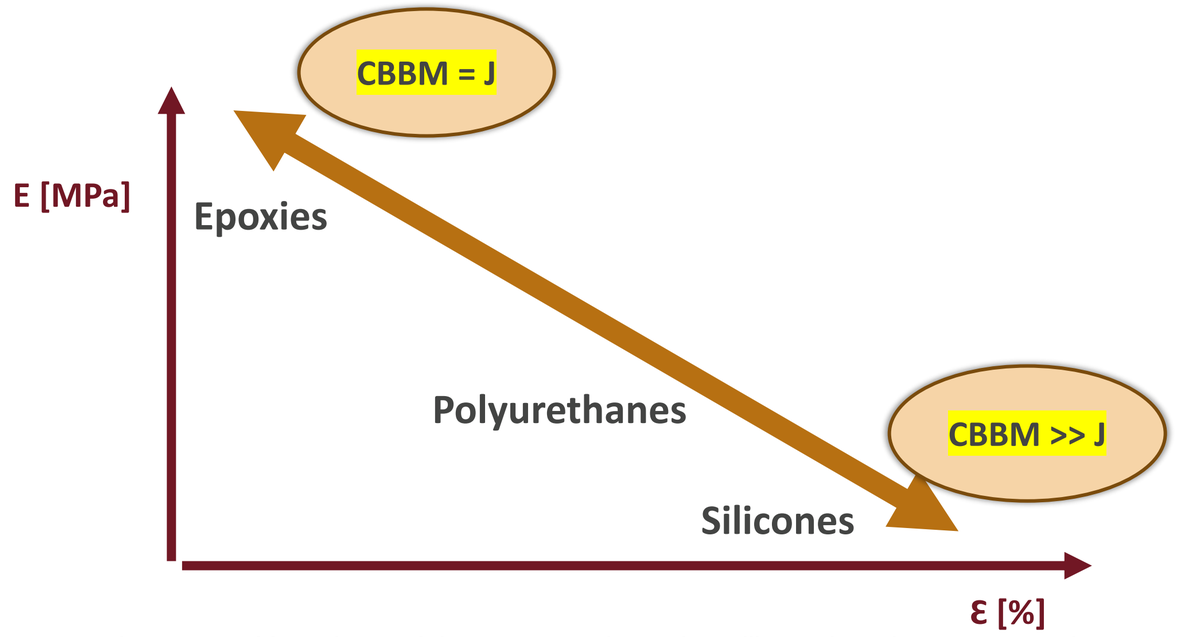

Figure 4 - Young's modulus versus elongation, illustrating the correspondence between the CBBM and J-integral methods across different regions, categorized by adhesive family types.