

# STATIC AND DYNAMIC YIELD STRESSES OF AEROSIL® 200 SUSPENSIONS IN POLYPROPYLENE GLYCOL

F.J. GALINDO-ROSALES<sup>1\*</sup> AND F. J. RUBIO-HERNANDEZ<sup>2</sup>

<sup>1</sup>Department of Mechanical Engineering and Mining, University of Jaen, 23071 Jaen, Spain

<sup>2</sup>Department of Applied Physics II, University of Malaga, 29071 Malaga, Spain

\* present address: Department of Chemical Engineering,  
Katholieke Universiteit Leuven, 3001 Heverlee, Belgium

\* Email: [curro@galindorosales.com](mailto:curro@galindorosales.com)

Fax: x34.951952514

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## ABSTRACT:

Fumed silica suspensions in low molecular weight liquids are used in many photonic and microelectronic applications, playing its rheology a major role in the effectiveness of their usage. Particle-particle and particle-liquid medium interactions of suspensions of hydrophilic fumed silica in low molecular weight polar media, polypropylene glycol of 400 and 750 g/mol, concretely, have been already investigated. There, the affinity between polar solvent molecules and fumed silica particles prevents the formation of a 3D gel network. In this work it has been found that fumed silica can develop a flocculated suspension when it is dispersed in polypropylene glycol with a molecular weight of 2000 g/mol. Besides, it has been found that this suspension exhibits time dependent behaviour within its reversible shear thinning region, which is related to thixoelectricity. The experimental method, proposed theoretically by Cheng in 1986 to obtain the dynamic yield stress in thixotropic systems has been here extended successfully to a thixoelectric system.

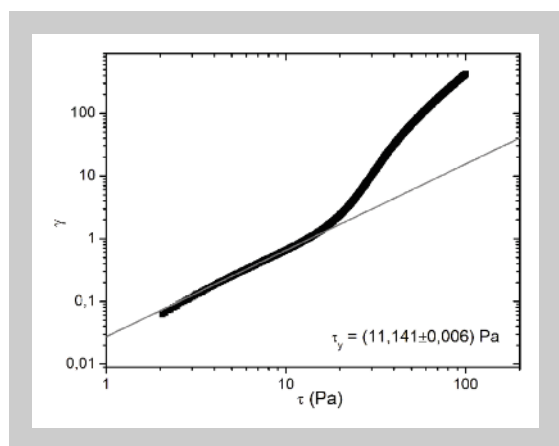
## ZUSAMMENFASSUNG:

Suspensionen aus Quarzstaub in niedermolekularen Flüssigkeiten werden in vielen photonischen und mikroelektronischen Anwendungen verwendet. Dabei spielen die rheologischen Eigenschaften eine wesentliche Rolle hinsichtlich der Anwendungseigenschaften. Partikel-Partikel- und Partikel-Matrix-Wechselwirkungen in Suspensionen von hydrophilem Quarzstaub in niedermolekularen polaren Medien (Polypropylenglykol mit einem Molekulargewicht von 400 bzw. 750 g/mol) wurden untersucht. In diesen Systemen verhindert die Affinität zwischen den polaren Lösungsmittelmolekülen und den Quarzstaubpartikeln die Bildung eines dreidimensionalen Gelnetzwerkes. In dieser Arbeit wird gezeigt, dass Quarzstaub eine ausgeflockte Suspension bildet, wenn es in Polypropylenglykol mit einem Molekulargewicht von 2000 g/mol dispergiert wird. Darüber hinaus wurde gefunden, dass die Suspension ein zeitabhängiges Verhalten innerhalb des reversiblen Bereiches der Scherverdünnung aufweist, das im Zusammenhang mit Thixoelektrizität steht. Die experimentelle Methode, deren theoretischer Ansatz von Cheng 1986 vorgeschlagen wurde, um die dynamische Fließspannung in thixotropen Systemen zu messen, wurde hier erfolgreich auf thixoelektrische Systeme übertragen.

## RÉSUMÉ:

Les suspensions de silice fumée dans des liquides de bas poids moléculaire sont utilisées dans de nombreuses applications en photonique et microélectronique. Leurs propriétés rhéologiques jouent un rôle majeur dans les performances d'utilisation de ces suspensions. Les interactions particule-particule et milieu liquide-particule dans des suspensions de silice fumée hydrophiles dans du polypropylène glycol de 400 et 750 g/mol ont été étudiées en particulier. Dans ce cas, l'affinité entre les molécules de solvant polaire et les particules de silice fumée empêchent la formation d'un réseau 3D gélifiant. Dans de travail, on a trouvé que la silice fumée peut développer une suspension floculée quand elle est dispersée dans du polypropylène glycol de masse moléculaire de 2000 g/mol. En revanche, il s'avère que cette suspension présente un comportement qui dépend du temps dans sa région rhéo-amincissante réversible, qui est due à la thixoelectricité. La méthode expérimentale proposée en théorie par Cheng en 1986 afin d'obtenir une contrainte seuil dynamique dans les systèmes thixotropiques, a été ici étendue avec succès à un système thixoelectrique.

**KEY WORDS:** fumed silica, static yield stress, dynamic yield stress, thixotropy, colloidal suspension



A200 particles and PPG molecules tends to form hydrogen bonds, due to fumed silica particles are hydrophilic and the polymer is a polar organic liquid. In spite of that, it has been found that it is possible to obtain a flocculated suspension. Only it is needed a dispersing media with chains long enough, at least of the same order of magnitude that the particle diameter, to reduce the effectiveness of the solvation of the particle. Then, having resting time long enough to let the primary particle aggregates contact each other, they are able to develop a volume filling network structure. Second, the use of the experimental method proposed theoretically by Cheng [7] has been successfully applied to a thixoelectric system (suspension of A200 in PPG2000 at 5 %v/v) in order to determine its DYS value. It has also been found that the value of SYS and DYS does not coincide, so more than one kind of microstructure must have been developed by A200 in PPG2000.

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Figure 9:  
Experimental determination of SYS value as the limit of elastic deformation range of A200 suspension in PPG2000 at 5 %v/v by applying a steady stress sweep from 0 to 100Pa.

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