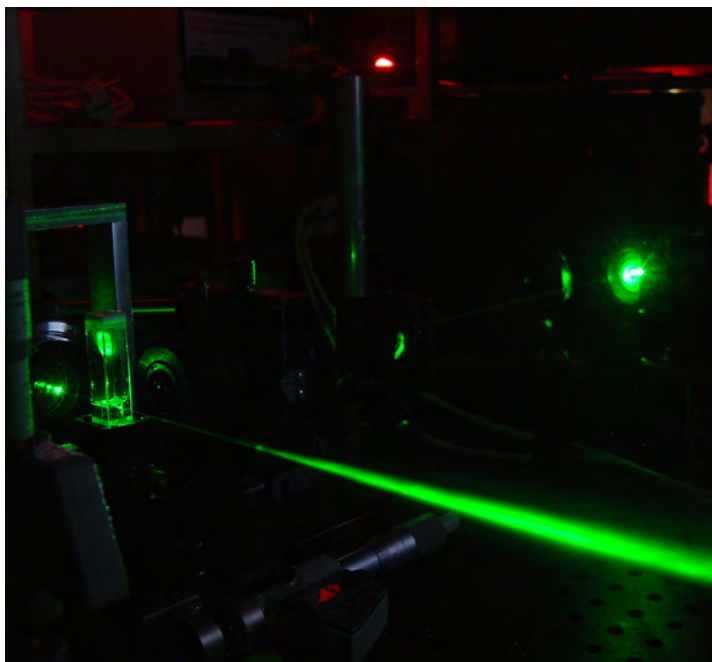


Caractérisation structurale de verre Ge-S-I pour l'élaboration et l'optimisation de fibres multimatériaux



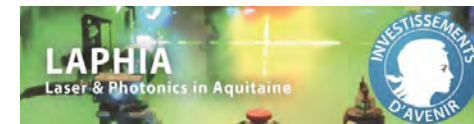
Matthieu Chazot
Matthieu.chazot.1@ulaval.ca

Sous la direction des professeurs:

Younès Messaddeq / COPL
Vincent Rodriguez / ISM

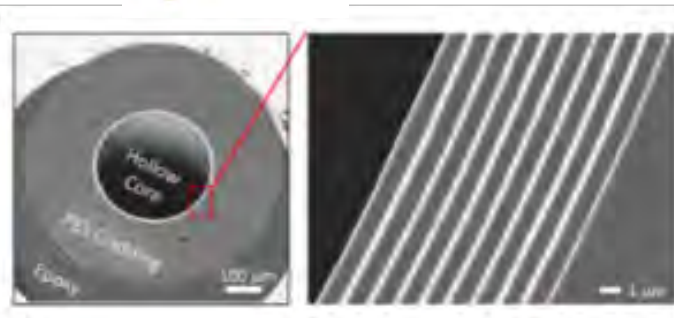


GDR Verres
GDR 3338

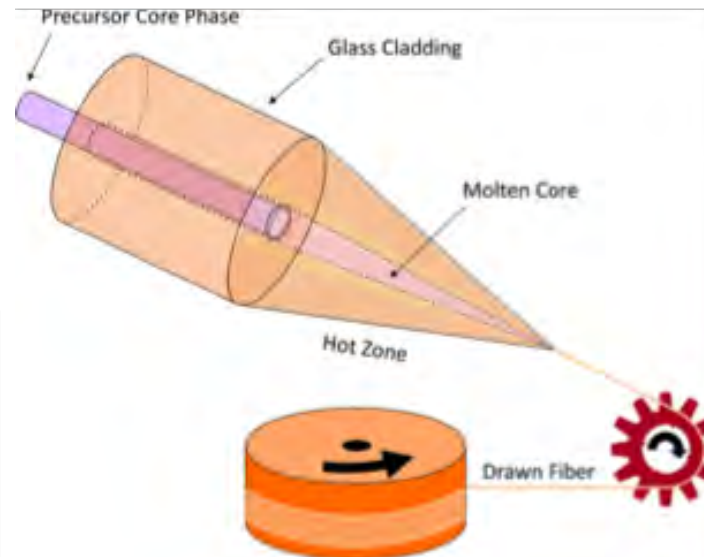


Fibres optiques multimatériaux

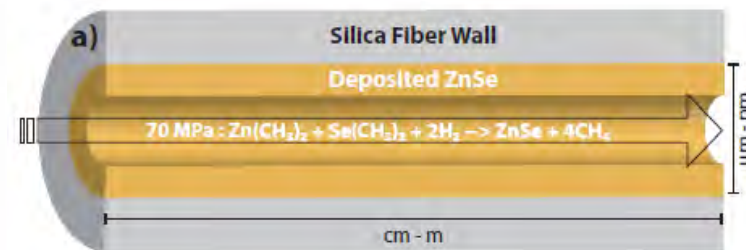
Fibres multimatériaux à Band-gap photonique



Fusion dans le cœur d'une préforme

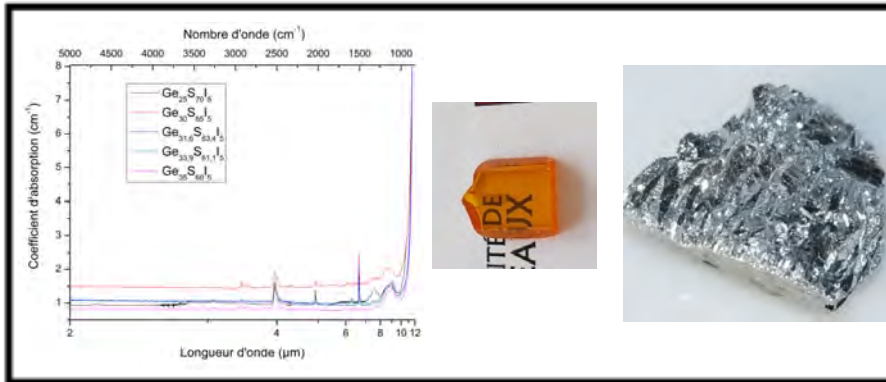


Fibres optiques de ZnSe / CVD

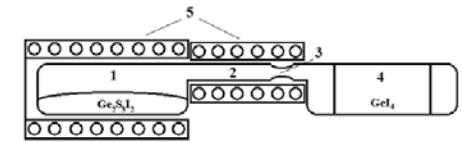


G. Tao, H. Ebandorff-Heidepriem, A. M. Stolyarov, S. Danto, J. V. Badding, Y. Fink, J. Ballato, Abouraddy, and A. F., "Infrared fibers," *Adv. Opt. Photonics*, vol. 7, pp. 379–458, 2015
J. Ballato and P. Dragic, "Rethinking Optical Fiber: New Demands, Old Glasses," *J. Am. Ceram. Soc.*, vol. 96, no. 9, pp. 2675–2692, 2013
J. R. Sparks, R. He, N. Healy, M. Krishnamurthi, A. C. Peacock, P. J. a Sazio, V. Gopalan, and J. V. Badding, "Zinc selenide optical fibers," *Adv. Mater.*, vol. 23, no. 14, pp. 1647–1651, 2011

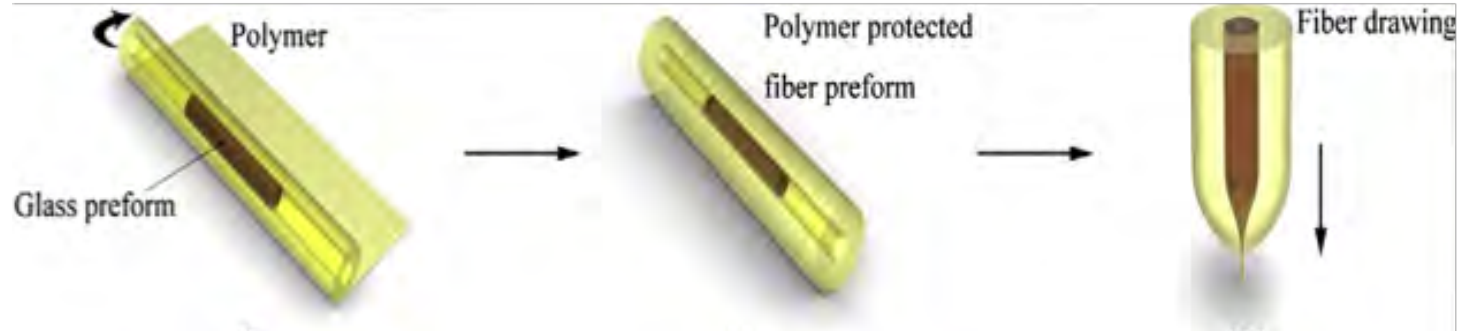
Fibres multimatériaux composées de verres Ge-S-I



Nouvelles méthodes de synthèse avec pureté améliorée
+
Obtention de fibres optiques de Ge-S-I par la méthode simple creuset

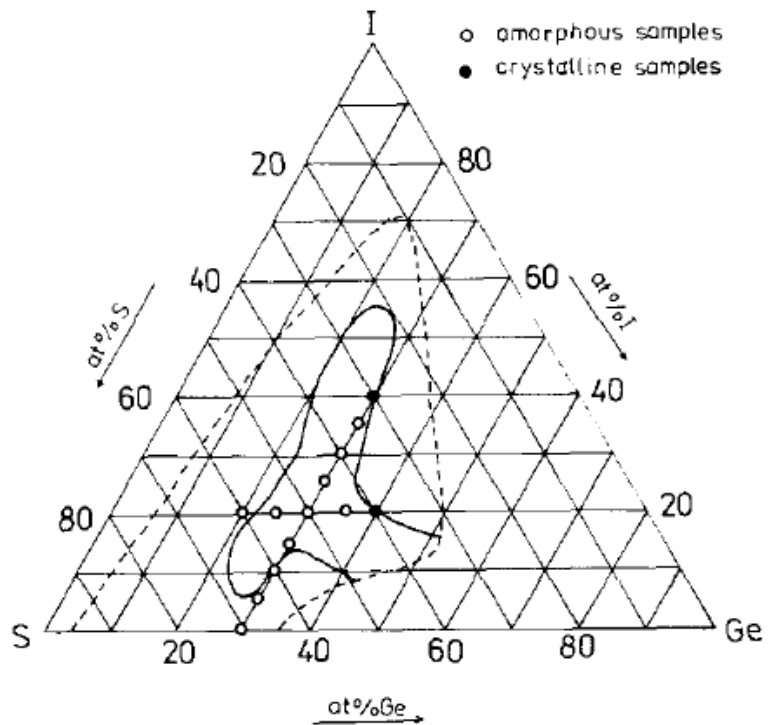


Fibres multimatériaux Ge-S-I / polymère



P. Velmuzhov, and M. F. Churbanov, "New method for preparation of specially pure glasses in the Ge – S – I system by melting the products of thermal decomposition of Ge₂S₃I₂,"
P. Velmuzhov, M. V. Sukhanov, A. D. Plekhovich, G. E. Snopatin, and M. F. Churbanov, "Preparation and investigation of Ge – S – I glasses for infrared fiber optics,"
M. Zhu, X. Wang, C. Jiang, G. Tao, and X. Zhang, "Infrared Physics & Technology Freely adjusted properties in Ge – S based chalcogenide glasses with iodine incorporation,"

Compositions des verres Ge-S-I synthétisés



Compositions	Tg (°C)
Ge25S70I5	275
Ge30S65I5	360
Ge31.6S63.4I5	370
Ge33.93S61.13I4.8	391
Ge35S60I5	381
Ge31S61I8	360
Ge25S65I10	260
Ge30S60I10	340
Ge30.5S59.5I10	355
Ge31S59I10	375
Ge31.7S58.3I10	385
Ge33.5S55.7I10.8	325
Ge35S55I10	306
Ge25S60I15	210
Ge28.3S56.7I15	262

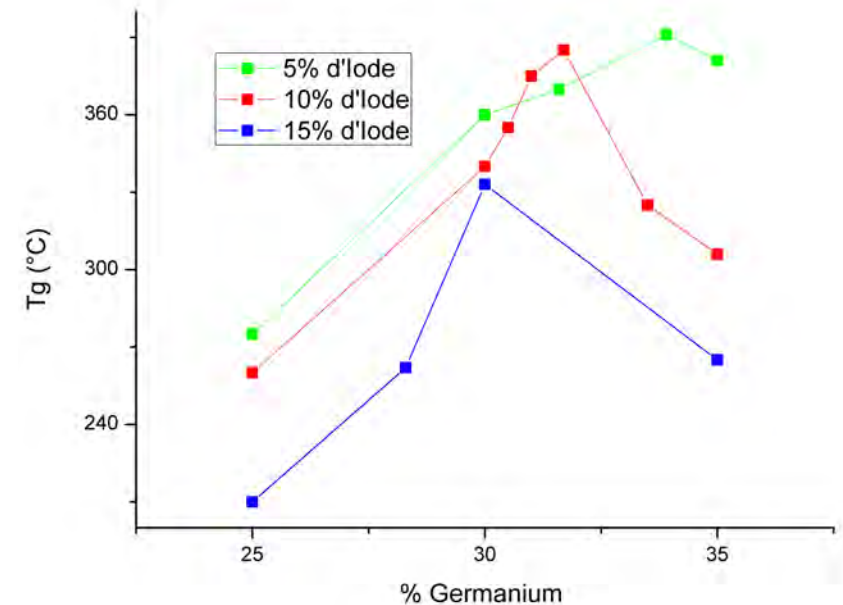
13, pp. 239-

L. Koudelka and M. PISARCIK, "RAMAN STUDY OF SHORT-RANGE ORDER IN G-S-I", 245, 1989

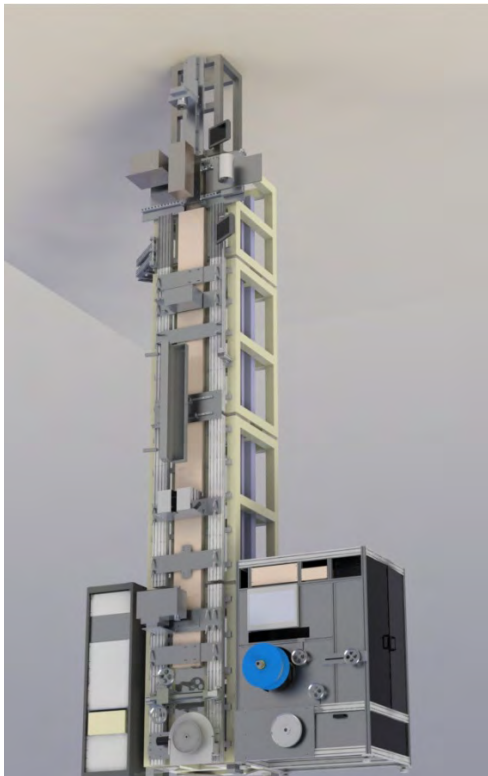
(GeS₂)₁₀₀

-xI_x

I₂ est modificateur de réseaux

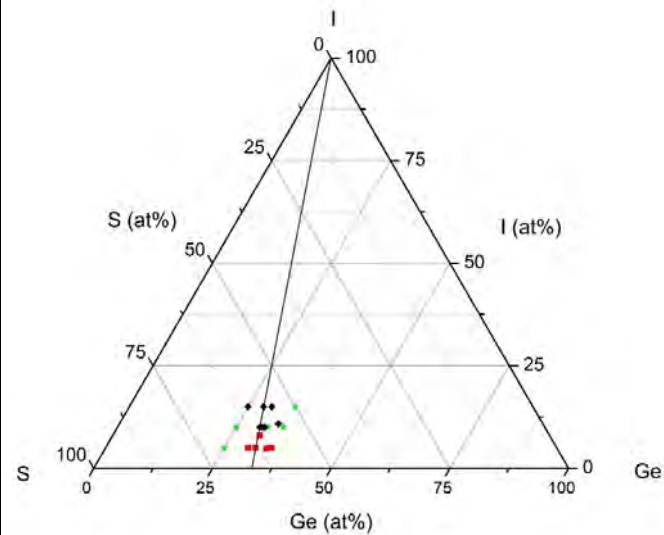


Fibres optiques Ge-S-I



Compositions	T _g (°C)
Ge25S70I5	275
Ge30S65I5	360
Ge31.6S63.4I5	370
Ge33.93S61.13I4.84	391
Ge35S60I5	320
Ge31S61I8	360
Ge25S65I10	260
Ge30S60I10	340
Ge30.5S59.5I10	355
Ge31S59I10	375
Ge31.7S58.3I10	385
Ge33.5S55.7I10.8	325
Ge35S55I10	306

Fibrage à partir d'une préforme



Caractérisation structurale des verres Ge-S-I

Corrélation structure - propriété



Analyse multimodale
Et déconvolution simultanée
des spectres IR, RS-VV (//)
RS-HV (\perp)

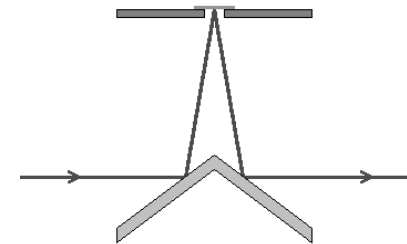
Compositions proche de la
Stœchiométrie



Spectres IR
réflexion spéculaire externe
à incidence casi-normale

Traitement de KK \rightarrow $\begin{matrix} n & \& \\ k \end{matrix}$

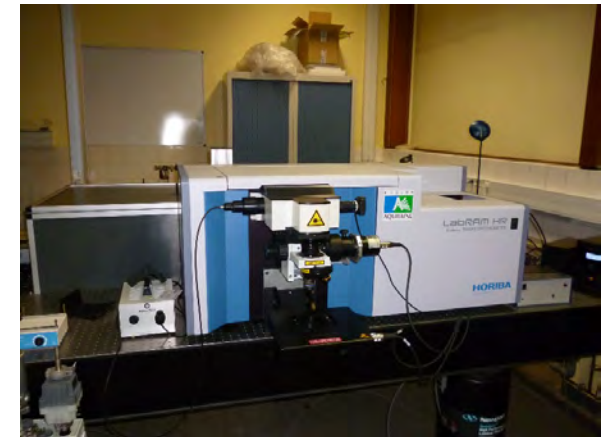
$$\epsilon'' = 2.n.k$$



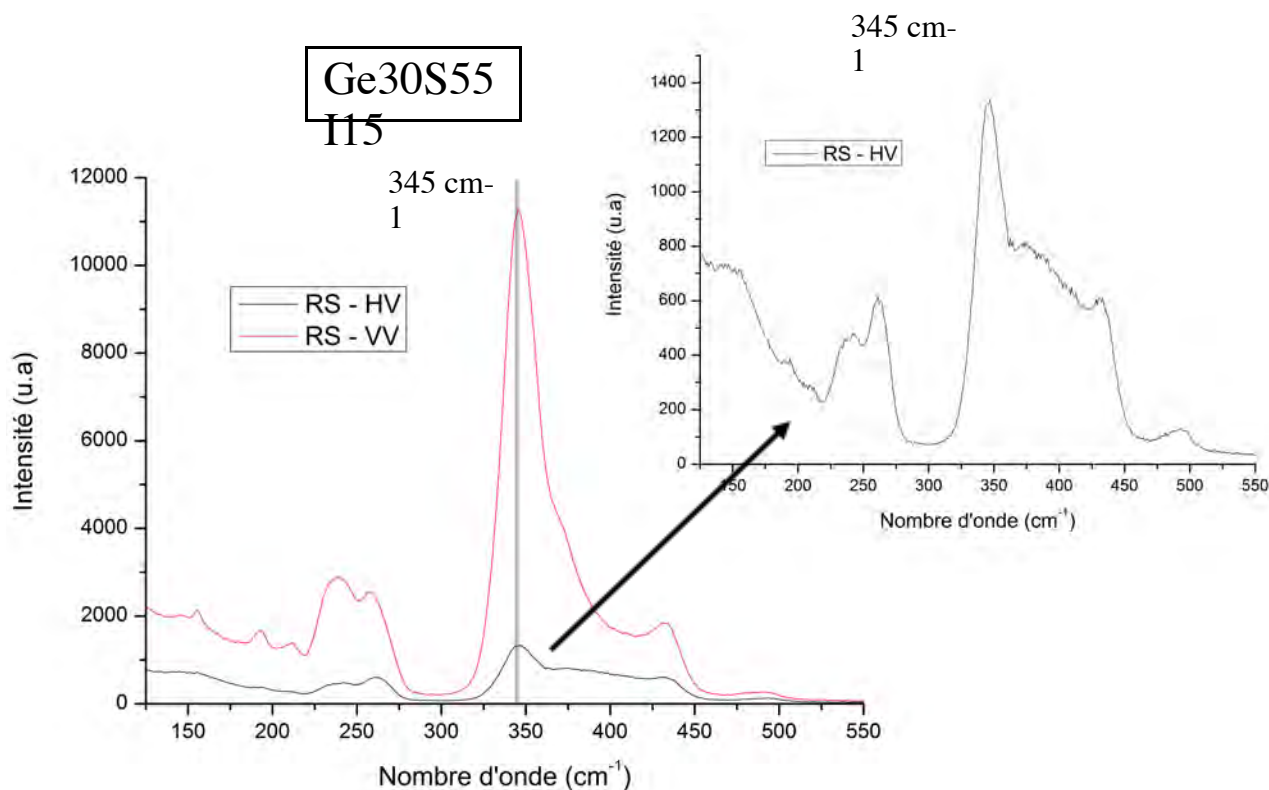
Spectres microRaman
VV et HV

Laser Kr+ @ 752 nm

Correction du facteur de
Bose-Einstein

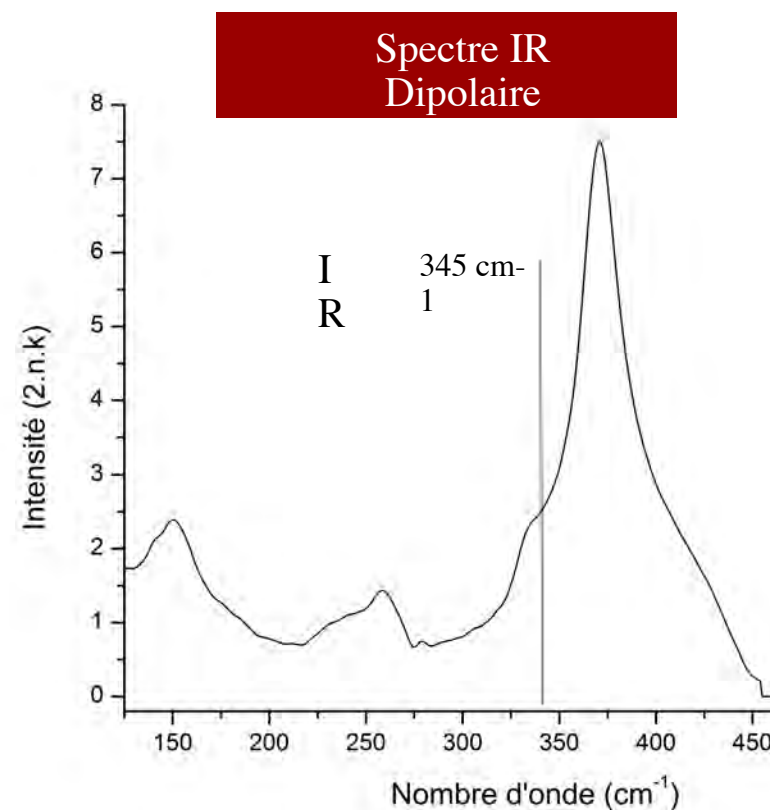


Caractérisation structurale des verres Ge-S-I

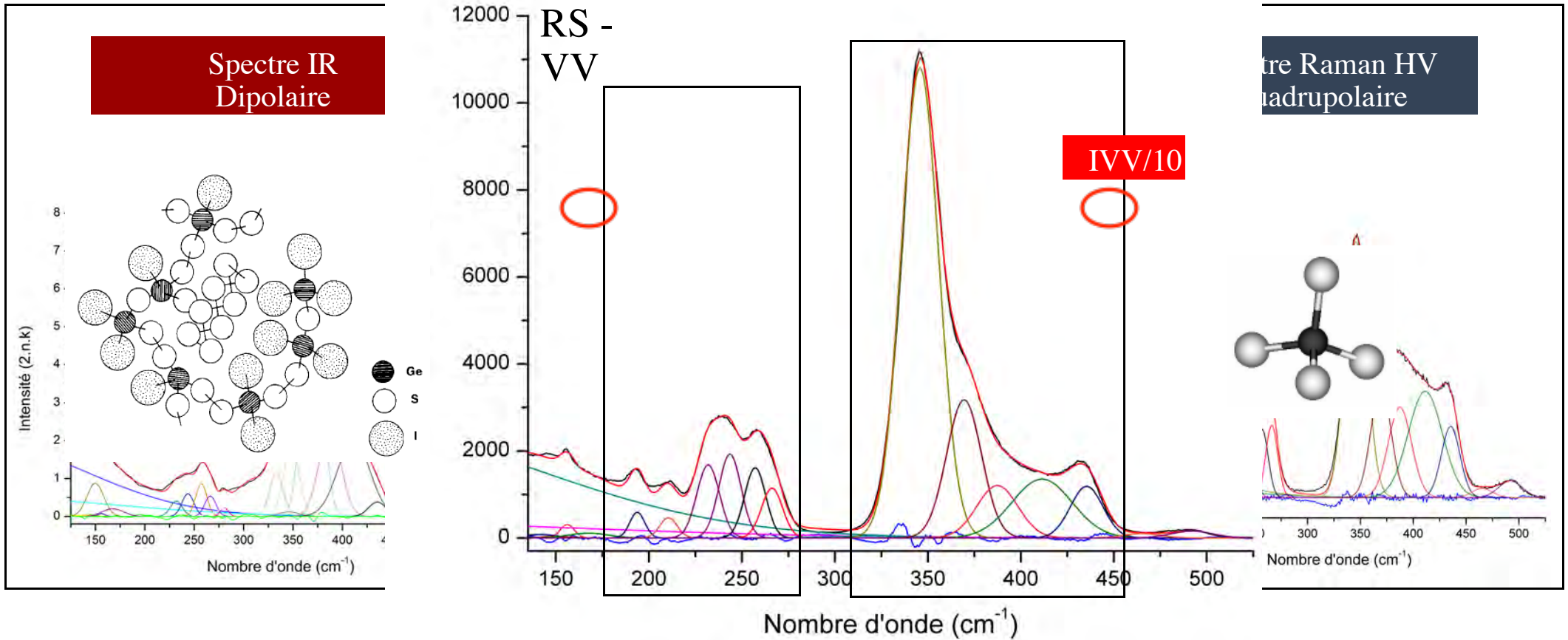


Spectre Raman VV
~ isotrope ≈ Raman non-polarisé

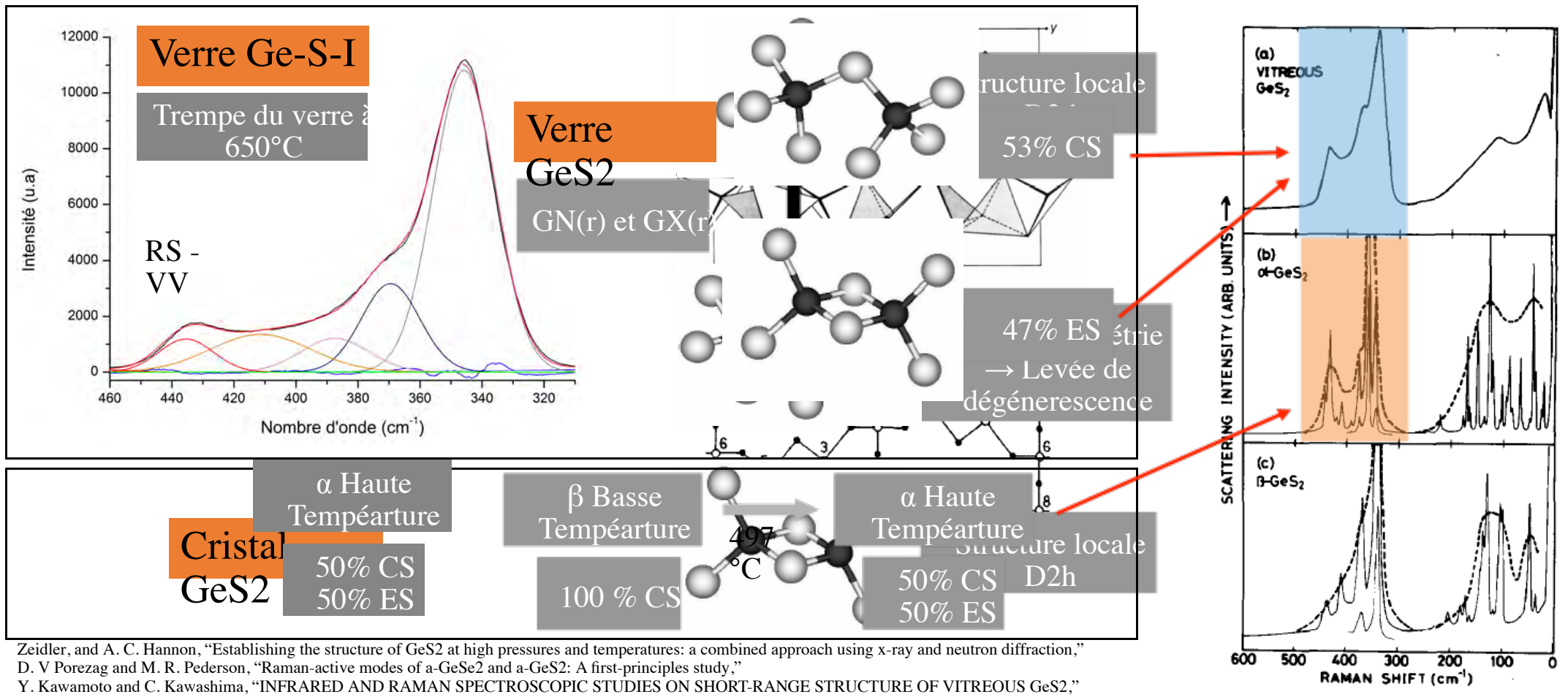
Spectre Raman HV
Quadrupolaire



Déconvolution des spectres du verre Ge₃₀S₅₅I₁₅

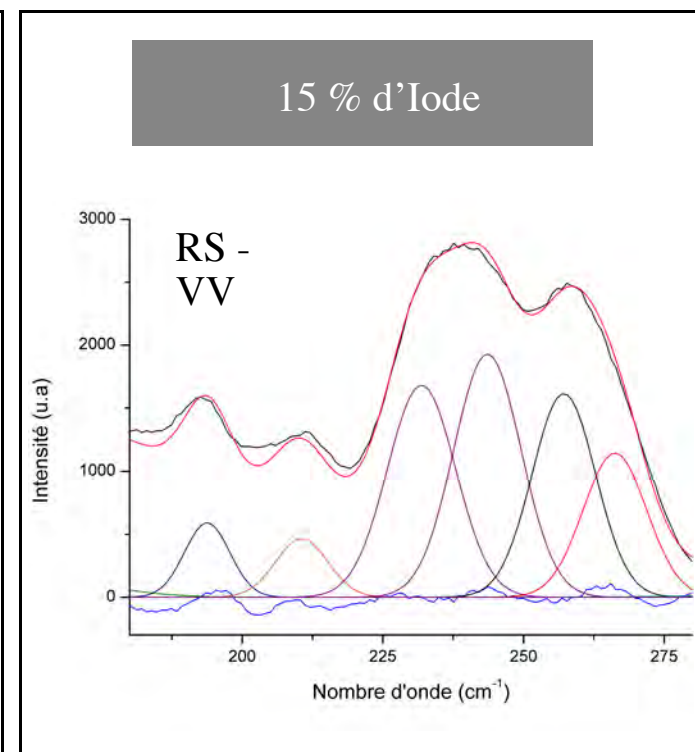
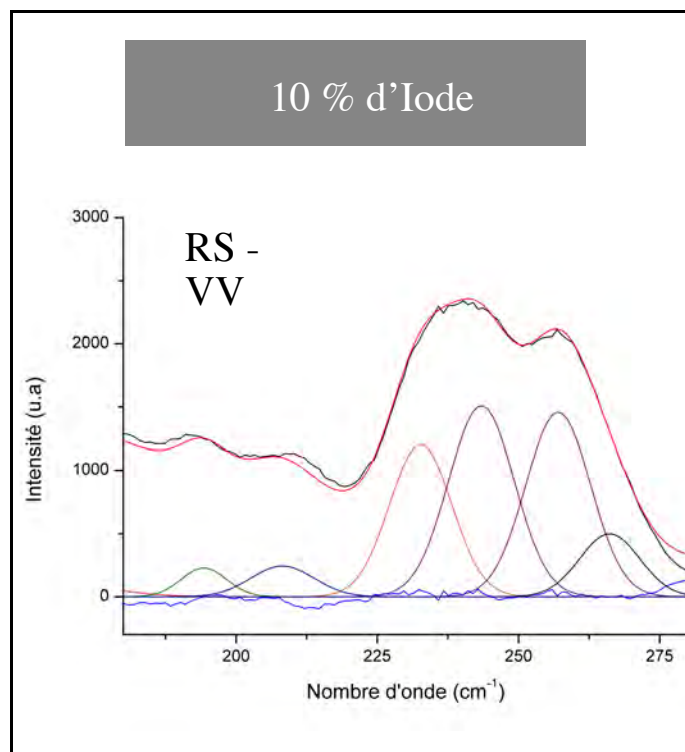
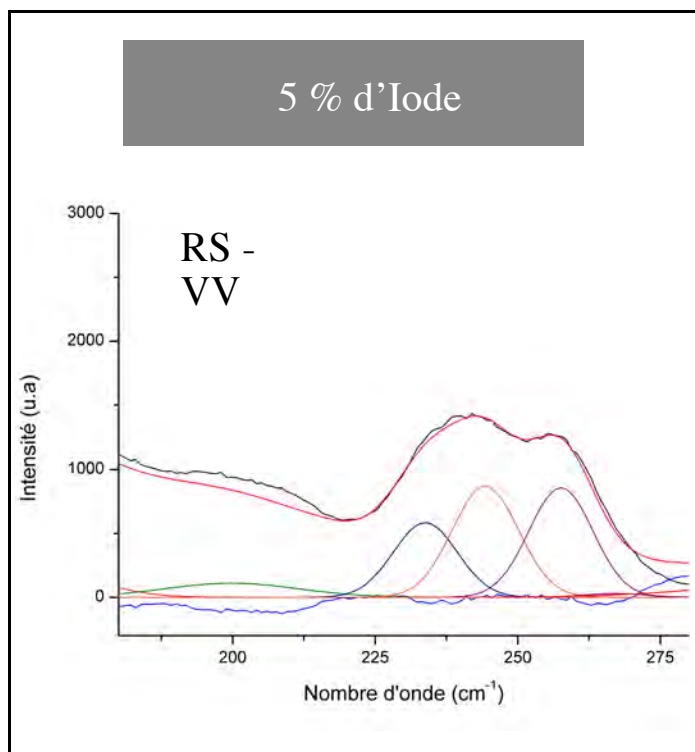


Caractérisation structurale des verres Ge-S-I

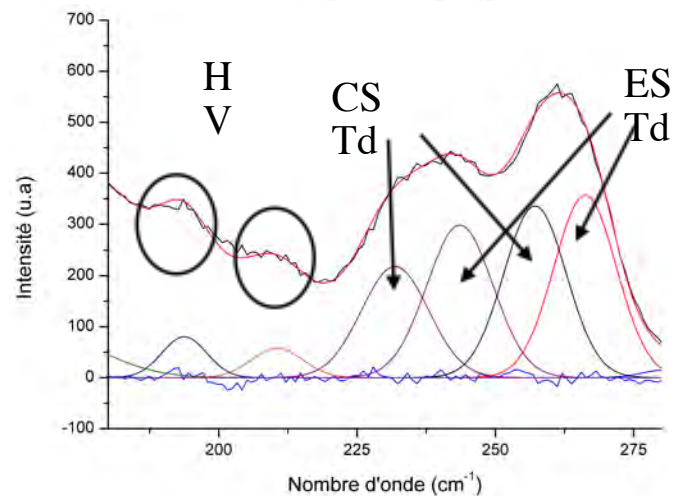
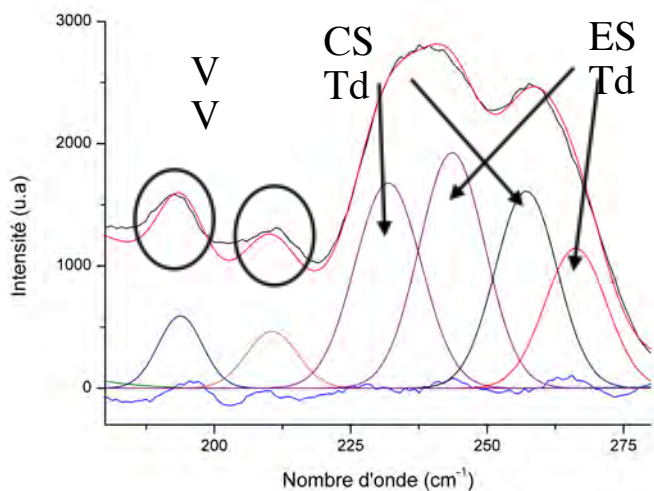
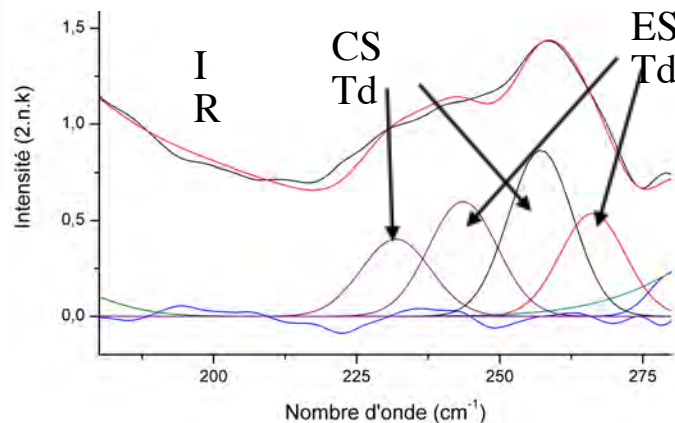
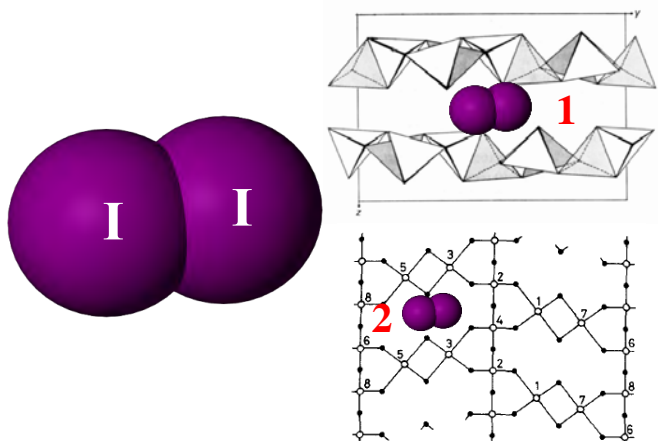


Zeidler, and A. C. Hannon, "Establishing the structure of GeS₂ at high pressures and temperatures: a combined approach using x-ray and neutron diffraction,"
 D. V Porezag and M. R. Pederson, "Raman-active modes of α-GeSe₂ and α-GeS₂: A first-principles study,"
 Y. Kawamoto and C. Kawashima, "INFRARED AND RAMAN SPECTROSCOPIC STUDIES ON SHORT-RANGE STRUCTURE OF VITREOUS GeS₂,"

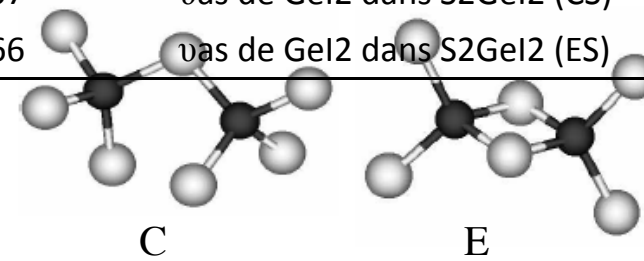
Caractérisation structurale des verres Ge-S-I



Caractérisation structurale du verre Ge₃₀S₅₅I₁₅



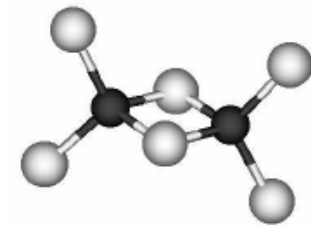
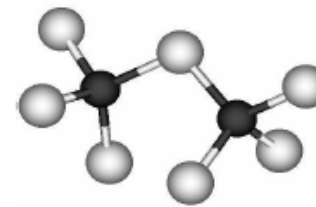
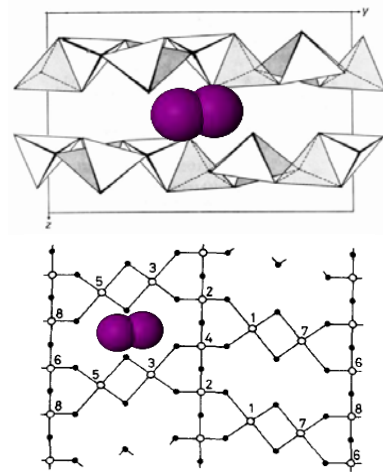
Position des pics (cm ⁻¹)	Attributions
190	I ₂ cristal (site 1)
210	I ₂ en solution (site 2)
231	us de GeI ₂ dans S ₂ GeI ₂ (CS)
243	us de GeI ₂ dans S ₂ GeI ₂ (ES)
257	vas de GeI ₂ dans S ₂ GeI ₂ (CS)
266	vas de GeI ₂ dans S ₂ GeI ₂ (ES)



A. Bernussi and G. M. Guaberto, "Raman Spectra of Br₂, Cl₂, and I₂, on Various Substrates," *J. Raman Spectrosc.*, vol. 18, no. February 1986, pp. 93–95, 1987
 H. J. Strauss, "The resonance Raman spectrum of I₂ in solution," *J. Indian Inst. Sci.*, vol. 68, pp. 493–504, 1988
 J. K. Durg, C. F. Jumper, and J. J. N. Willis, "Vibrational Spectra and Structure of organo-germanes. Normal Modes and Torsional and Barrier of CH₃GeI₃ and CD₃GeI₃," *Journal Mol. Spectrosc.*, vol. 37, pp. 260–271, 1971

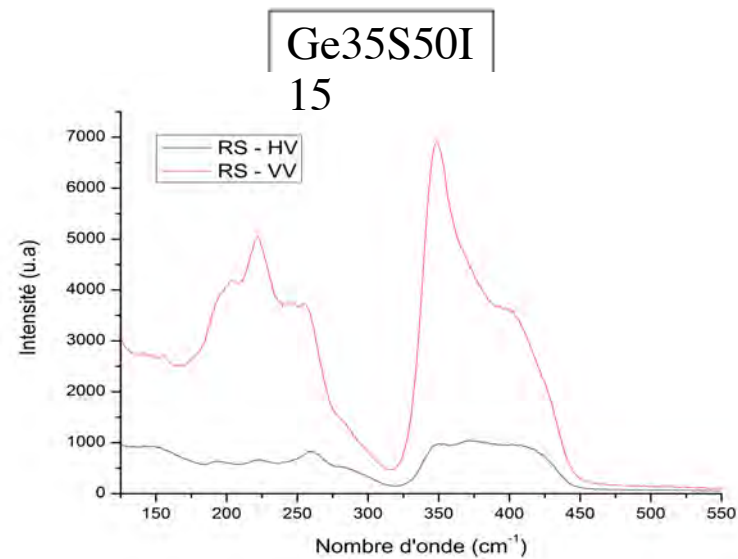
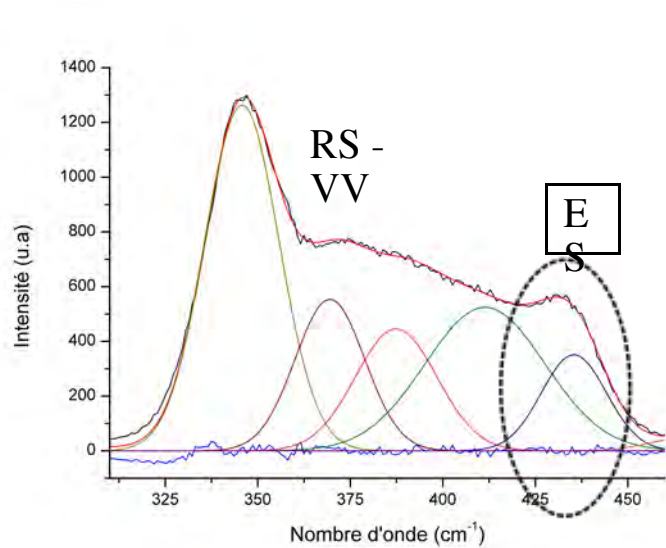
Conclusion

- Obtention de fibres optiques de verres Ge-S-I sur une large gamme de compositions
- Caractérisation structurale multimodale des verres et déconvolution simultanée des spectres IR, Raman VV et HV
- Présentation d'un nouveau modèle permettant l'attribution des bandes dans la région 180-280 cm^{-1} reliées au diiode



Perspectives

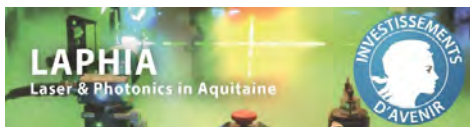
- Étude de l'évolution des bandes dans la région 320-460 cm^{-1} en fonction de la stœchiométrie Ge-S
- Déconvolution des spectres pour les verres sur-stœchiométrique en Germanium





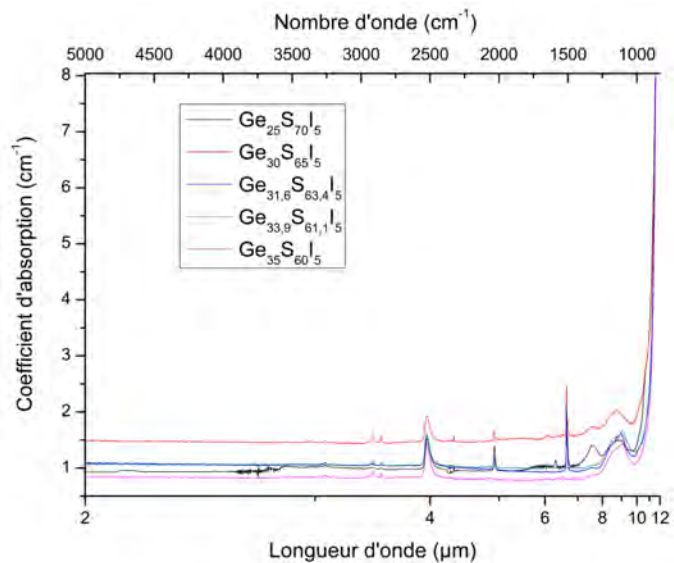
Merci pour attention !

GDR Verres
GDR 3338

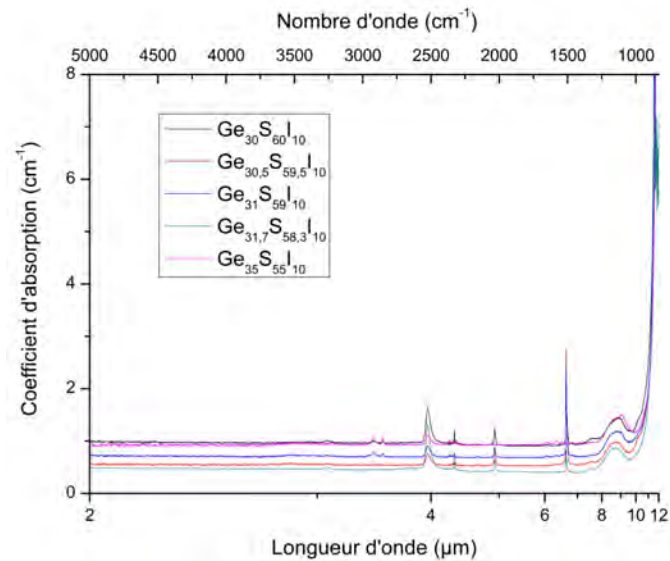


Spectres FTIR des verres Ge-S-I

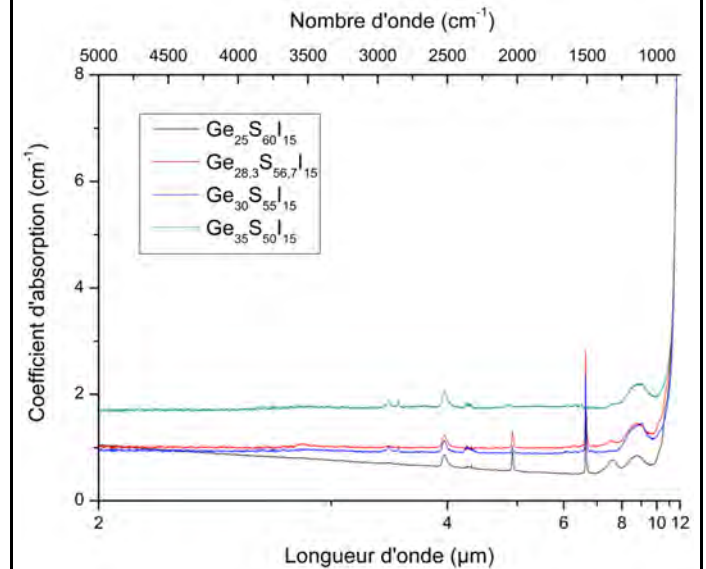
5 % d'Iode



10 % d'Iode

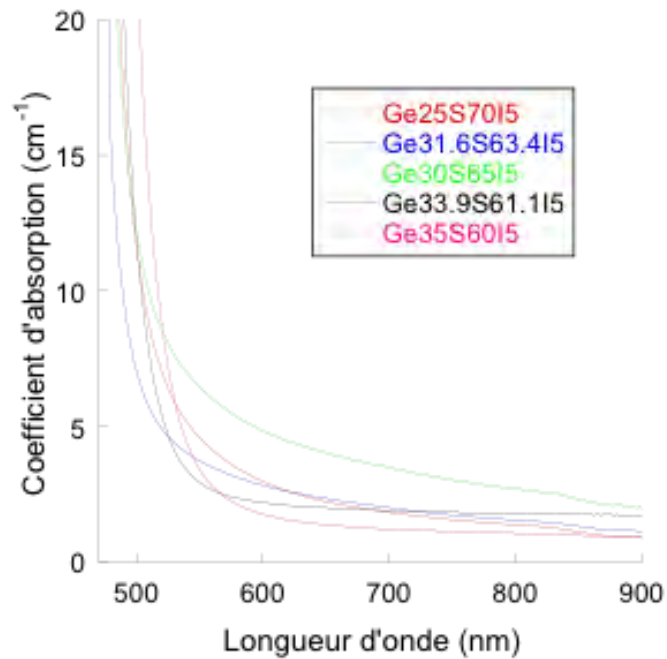


15 % d'Iode

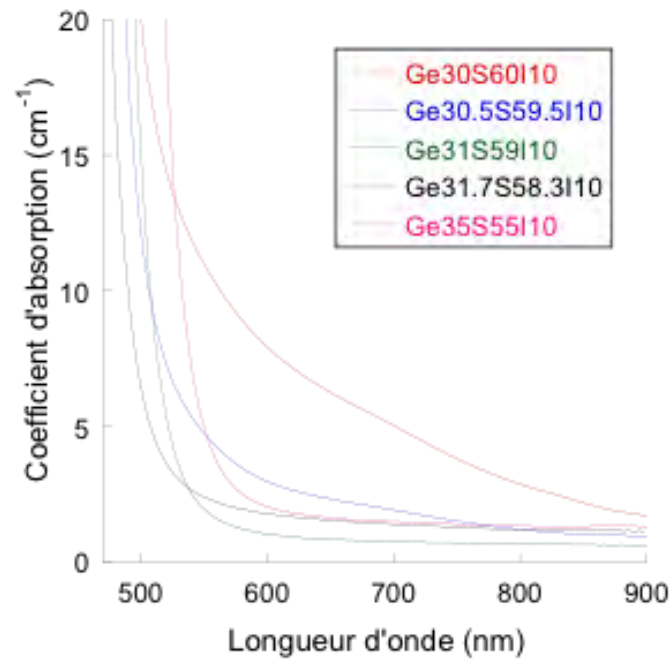


Spectres dans le visible des verres Ge-S-I

5 % d'Iode



10 % d'Iode



15 % d'Iode

